1968

Guide to Estuarine and Inshore Bivalves of Virginia

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GUIDE TO ESTUARINE AND INSHORE BIVALVES OF VIRGINIA

A Thesis

Presented to

The Faculty of the School of Marine Science

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

By

Donna DeMoranville Turgeon

1968

APPROVAL SHEET

This thesis is submitted in partial fulfillment of

the requirements for the degree of

Master of Arts

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Approved, August 1968

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ACKNOWLEDGEMENTS

The author wishes to express sincere gratitude to her major professor, Dr. Marvin L. Wass, whose guidance made the completion of this project possible. Grateful appreciation is extended to the following members of the author's committee: Dr. Jay D. Andrews for his assistance and criticism of this paper; Dr. John L. Wood and Dr. William J. Hargis, Jr., for their criticism of the manuscript; and Dr. Kenneth L. Webb for his aid and encouragement. Special thanks are due to Dr. William Clench, Dr. Ruth Turner and Dr. Kenneth Boss, members of the Department of Malacology of the Harvard Museum of Zoology, for their illustrations of the Teredinidae and Diplothyra smithii and their invaluable assistance. Mr. Paul Chanley supplied several specimens and invaluable data on salinity tolerance and general habitat.

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ABSTRACT

Illustrations of the internal valve features, concise descriptions of shell structure and a key to the 48 species of bivalves from Chesapeake Bay and sea side environ of Virginia are presented. Soft parts are not included except for some reference to siphons. The key is phylogenetic in arrangement, employing such internal diagnostic shell characters as type of hinge, number and form of lateral and cardinal teeth, muscle scars, pallial line and sinus. Descriptions are based on external and internal features of shells, but primarily on the latter. Labeled figures of the principal diagnostic features are provided to orient the user. A glossary of malacological terms is included. Information on habitat, salinity tolerance, ranges and local distribution is given. The range of Cyclinella tenuis is extended.

GUIDE TO ESTUARINE AND INSHORE BIVALVES OF VIRGINIA

INTRODUCTION

Major works on the western Atlantic mollusks include early publications by De Kay (1843), Gould (1870), Verrill and Bush (1898) and Dall (1900). Recent works designed for popular consumption are those of Morris (1951), Abbott (1954) and Jacobson and Emerson (1961). The handbook of Miner (1950) and the "Woods Hole keys" (Smith, 1964) include mollusks along with other invertebrate groups and are more useful north of Chesapeake Bay. The most scholarly publications are those found in Johnsonia, a serial publication devoted to molluscan taxonomy.

The only complete checklist of western Atlantic mollusks is that of Johnson (1934). Checklists of the marine bivalves of Virginia have been compiled by Andrews (1956) and Wass (1965). A few of the species included in this work are not found in the latter lists. Additional species may occur in seaside bays and ocean beaches; it is unlikely that others presently exist in Chesapeake Bay.

The form and general approach of Tebble (1966) were adapted for this work. While only a few species from Chesapeake Bay are included in Tebble's work, his is one of the best illustrated and well-ordered guides available. Tebble's volume on British bivalves and that of Keen (1958) on tropical eastern Pacific bivalves have excellent descriptions of superfamilies which have been valuable to this study.

Literature on mollusks has rarely employed descriptions of internal shell characteristics. External features are often more variable due to erosion of the periostracum or morphological changes caused by the substrate. The internal form may also be altered by environmental factors; however, basic structural features including the hinge, muscle scars and pallial attachments are typically consistent. The order of presentation follows the phylogenetic classification of Keen (1963). Two introductory figures are provided with legends. Figures of the inner surface of one valve, usually the left, are provided for each of the 48 species. This work is presented for use by experienced workers, but beginning students should find little difficulty with the aid of the glossary and the figures. Tabular comparisons of species in the superfamilies Nuculacea, Arcacea, Mytilacea, Erycinacea, Veneracea, Tellinacea, Solenacea, Mactracea and Pholadacea are included.

The Virginia pelecypod fauna is limited in diversity of species but often abundant in numbers, which is typical of estuarine habitats. Some, such as Mulinia lateralis, are quite sporadic in abundance. Scarce to rare members of the fauna include Polymesoda caroliniana, Cyclinella tenuis, Pitar morrhuana, Pandora trilineata and Cardiomya gemma. Others, such as Cyrtopleura costata and Dosinia discus, are seldom taken because of their deep burrowing habits. Two important food species, the oyster and the bay scallop, have suffered reductions because of diseases in recent decades. Most bivalves, particularly juveniles, are subject to intense predation by fishes and invertebrates. The marsh clam, Rangia cuneata, has apparently been introduced into

the James and the Potomac rivers rather recently (Pfitzenmeyer and Drobeck, 1964) and has become very abundant. A few bivalves, particularly the commensals Aligena elevata and Mysella bidentata as well as P. caroliniana, Barnea truncata, Petricola pholadiformis and Diplothyra smithii, which fill niches in restricted habitats, are not easily found by the casual observer.

The purpose of this work is to facilitate identification of bivalves of Chesapeake Bay and the bays, sounds and beaches of the Virginia coast. The present work attempts to bridge certain gaps in previous publications. For example, internal characteristics provide easy separation of Tellina agilis and Macoma phenax. M. phenax, common in brackish creeks, is not included in popular guides. M. lateralis, a common and often abundant species, is not indexed in Morris (1951) and Abbott (1954). C. tenuis has been noted only in a guide to Caribbean shells by Warmke and Abbott (1961). It is hoped that this work will be useful to those who found the literature inadequate.

KEY TO THE MARINE BIVALVES OF VIRGINIA

1 Dentition taxodont with numerous small teeth. (2)
Dentition other than taxodont. (6)

2 Ligament internal, lying below beaks in small pit, separating anterior and posterior row of teeth; hinge usually curved, beaks in close contact..... ..... NUCULACEA, p. 12 (3)

Ligament external, in chevron-shaped grooves; hinge line straight, beaks usually not in close contact..... ARCACEA, p. 15 (4)

3 Shell symmetrical, obliquely ovate, closing tightly; pallial sinus lacking..... ..... Nucula proxima, p. 12, fig. 1

Shell asymmetrical, elongate, gaping widely; pallial sinus deep..... Yoldia limatula, p. 13, fig. 2

4 Left valve extending slightly beyond right; beaks closely or moderately separated and directed toward anterior or center of shell; adductors impressed. (5)
Left valve not extending beyond right; beaks widely separated and directed posteriorly; adductors elevated..... Noetia ponderosa, p. 15, fig. 5

5 Beaks directed centrally, moderately separated; external ribs beaded; shell rhomboidal-ovate..... ..... Anadara transversa, p. 17, fig. 6

Beaks directed anteriorly, nearly touching; external ribs square; shell roundly ovate..... ..... Anadara ovalis, p. 18, fig. 7

6 Valves with one adductor muscle scar, monomyarian. (12)
Valves with two adductor muscle scars. (7)

7 Adductor muscle scars markedly unequal, heteromyarian; pallial sinus lacking. (8)
Adductor scars about the same size, dimyarian (not necessarily same shape); pallial sinus may be present. (14)

8 Hinge line with crenulate process, or smooth; umbones at anterior end..... MYTILACEA, p. 19, (9)
Hinge line with septifer (shelf-like extension of hinge into tissue) or with cardinal and lateral teeth; umbones may be at anterior end. (17)

9 External valves ribbed; inner margin crenulate. (10)
External valves not ribbed; inner margin smooth. (11)

10 Ribs wavy, shell recurved; hinge with 3-4 small crenulations..... Brachidontes recurvus, p. 20, fig. 8

Ribs bifurcate, shell not recurved; hinge lacking crenulations..... Modiolus demissus, p. 21, fig. 9

11 Shell firm, opaque; hinge with 3-12 crenulations, umbones at anterior tip; color blue-black.....
..... Mytilus edulis, p. 22, fig. 10

Shell fragile, transparent; hinge lacking crenulations, umbones a few mm from anterior tip; color light gray, yellow-brown to red-brown.....
..... Amygdlum papyria, p. 23, fig. 11

12 Hinge line drawn out on either side of beaks into lateral projections or ears; ligament internal in triangular pit below beaks; ribs corrugated.....
..... PECTINACEA, Aequipecten irradians, p. 25, fig. 12

Hinge line not drawn out into ears; ligament may or may not be in triangular pit; ribs generally lacking. (13)

13 Right (lower) valve with a prominent hole for calcified byssus attachment to substrate; upper valve thin, translucent, smooth; single adductor scar divided into one large scar and two accessory scars.....
..... ANOMIACEA, Anomia simplex, p. 27, fig. 13

Neither valve perforated; animal attached to substrate by left valve; valves thick, opaque, rough; adductor scar not divided.....
..... CSTREACEA, Crassostrea virginica, p. 29, fig. 14

14 Hinge line with cardinal and/or lateral teeth. (15)
Hinge line lacking teeth. (38)

15 One valve with at least three cardinal teeth. (16)
Each valve with a maximum of two cardinal teeth. (18)

16 Each valve with two bifid teeth and two lateral teeth; pallial sinus narrow.....
...CORBICULACEA, Polymesoda caroliniana, p. 31, fig. 15

Each valve with one bifid tooth, laterals variable in number; pallial sinus moderately wide. (21)

17 Both valves with a septifer and a triangulate process inside and projecting downward; umbones at anterior end; posterior adductor larger than anterior.....
.... DREISSENACEA, Congeria leucophaeata, p. 33, fig. 16

Left valve with two cardinals, laterals lacking; right valve with one cardinal and two laterals; umbones subcentral; anterior adductor larger than posterior.....
..... LUCINACEA, Lucina multilineata, p. 35, fig. 17

18 Pallial sinus present. (27)
Pallial sinus lacking. (19)

19 Valves with less than two cardinals and two laterals; ligament internal; byssus present; species reaching 6 mm..... ERYCINACEA, p. 37, (20)

Valves each with two cardinals two, laterals; ligament external; byssus lacking; species reaching lengths greater than 6 mm.....
..... CARDIACEA, Laevicardium mortoni, p. 40, fig. 18

20 Two cardinals in each valve, laterals lacking; commensal with Clymenella..... Aligena elevata, p. 37, fig. 19

Cardinals lacking, two laterals in each valve; commensal host unknown in Virginia.....
..... Mysella bidentata, p. 38, fig. 20

21 Two thin cardinals and wedge-shaped bifid tooth; ligament external, strong band..... VENERACEA, p. 42, (22)

One thin cardinal and two united to form $\wedge$-shaped projection; ligament internal in large chondrophore (small external element may be present).....
..... MACTRACEA, p. 63, (36)

22 Each valve with three cardinal teeth; sculpture mainly concentric lines or ridges. (23)
Left valve with three cardinal teeth, two cardinals in right; 40 or more prominent radial ribs with fine concentric lines.....
..... Petricola pholadiformis, p. 49, fig. 26

23 Shells compressed; margins smooth. (24)
Shells inflated; margins generally crenulate. (25)

24 Shell glossy, subcircular; sculpture fine concentric ridges (20/cm); left valve with small, knoblike anterior lateral..... Dosinia discus, p. 43, fig. 21

Shell dull, circular; sculpture irregular growth lines; laterals lacking. Cyclinella tenuis, p. 44, fig. 22

25 Hinge with laterals lacking or with obsolescent knob in anterior of left valve; periostracum distinct; species moderately large. (26)
Hinge with two distinct laterals; periostracum inconspicuous; species minute.....
..... Gemma gemma, p. 48, fig. 25

26 Laterals lacking; margins crenulate; pallial sinus shallow. Mercenaria mercenaria, p. 45, fig. 23

Anterior lateral in left valve knoblike; margins smooth; pallial sinus deep. Pitar morrhuana, p. 47, fig. 24

27 Beaks subcentral; hinge plate narrow; cruciform muscle scars present, may be indistinct. TELLINACEA, p. 50, (28)

Beaks at anterior end or in anterior fourth; hinge plate lacking; cruciform muscle scars lacking.....
..... SOLENACEA, p. 59, (34)

28 Shells light or fragile; each valve with two cardinals, one lateral or none; margins smooth. (29)
Shells moderately heavy, firm; left valve with two cardinals and two laterals, right valve with one cardinal and two laterals; margin crenulate.....
..... Donax variabilis, p. 56, fig. 32

29 Right valve with distinct anterior lateral.....
..... Tellina agilis, p. 51, fig. 28

Right valve with anterior lateral obsolescent, or lacking. (30)

30 Laterals lacking in right valve. (31)
Lateral indistinct groove on right valve.....
..... Abra aequalis, p. 55, fig. 31

31 Pallial sinus extending further in one valve than the other, reaching nearly to anterior adductor; shell generally ovate. (32)
Pallial sinus equal in size, extending to midline; shell oblongate with anterior truncate..... ..... Tagelus plebeius, p. 57, fig. 33

32 Shell broadly ovate, not gaping; sinus extending further toward anterior adductor in right valve; periostracum pale gray, thin..... Macoma balthica, p. 52, fig. 27

Shell not broadly ovate, not gaping; sinus extending further toward anterior adductor in left valve; periostracum inconspicuous. (33)

33 Shell suboval, slightly gaping..... ..... Macoma phenax, p. 53, fig. 29

Shell oval-elongate, posterior truncate and gaping moderately..... Macoma tenta, p. 54, fig. 30

34 Beaks in anterior fourth of shell; shell ovate-elongate; internal raised rib for support; right valve with bifid lateral..... Siliqua costata, p. 59, fig. 35

Beaks at anterior end; shell elongate-rectangulate; raised rib lacking; laterals lacking or not bifid. (35)

35 Two cardinals and one lateral in left valve, one cardinal and one lateral in right valve; dorsal and ventral margin curving dorsally..... ..... Ensis directus, p. 60, fig. 36

One cardinal in each valve, laterals lacking; dorsal and ventral margins straight..... ..... Solen viridus, p. 61, fig. 37

36 Ligament external and internal; chondrophore large, broad, spoon-shaped; laterals serrated. .... Spisula solidissima, p. 63, fig. 38

Ligament internal; chondrophore small, triangular; laterals lacking serrations. (37)

37 Shell triangulate with distinct external radial ridge; periostracum thin, yellow-brown left valve with two laterals, right with four..... ..... Mulinia lateralis, p. 65, fig. 39

Shell obliquely ovate with strong ridge lacking; periostracum strong, gray-brown; left valve with two laterals, right with three..... ..... Rangia cuneata, p. 66, fig. 40

38 Pallial sinus present. (39)
Pallial sinus lacking. (46)

39 Pallial sinus clear. (40)
Pallial sinus indistinct..... PANDORACEA, p. 77, (45)

40 Large, spoon-shaped, projecting chondrophore in left valve; anterior adductor elongate-suboval lying in anterior of shell; apophysis lacking; shell elongate to roundly ovate.....
..... MYACEA, Mya arenaria, p. 67, fig. 41

Chondrophore small, not projecting; anterior adductor elongate, lying on umbonal reflection; foot muscles attached to long, slender, projecting apophysis; shell shape variable..... PHOLADACEA, p. 69, (41)

41 Accessory plates developed about main shell; siphons united; condyles lacking. (42)
Accessory plates far removed from shell, such as pallets; siphons separated; condyles present. (44)

42 Protoplax lying anterior to umbones; mesoplax may be present; metaplax, hypoplax and callum lacking. (43)
Protoplax lacking; mesoplax, metaplax, hypoplax and callum covering gaping shell.....
..... Diplothyra smithii, p. 72, fig. 44

43 Shell rectangulate, posterior truncate; protoplax calcareous; mesoplax lacking.....
..... Barnea truncata, p. 70, fig. 42

Shell oval, rounded at both ends; protoplax chitinous; mesoplax lying anterior to protoplax.....
..... Cyrtopleura costata, p. 71, fig. 43

44 Pallets segmented, series of closely spaced cones.....
..... Bankia gouldi, p. 73, fig. 46

Pallets united, paddle-shaped.....
..... Teredo navalis, p. 75, fig. 45

45 Sinus slight; shell elongate-oval; posterior drawn out and pointed; moderately compressed; hinge lacking protuberances; periostracum with agglutinated sand grains..... Lyonsia hyalina, p. 77, fig. 47

Sinus represented by series of separate, small muscle scars; shell crescent-shaped, flat, posterior drawn out into rostrum; hinge with protuberances functioning as teeth in hinge; periostracum inconspicuous, lacking agglutinations..... Pandora trilineata, p. 78, fig. 48

46 Posterior extended into spout; ligament internal; margin crenulate where met by external ribs; periostracum inconspicuous.....
..... POROMYACEA, Cardiomya gemma, p. 80, fig. 49

Posterior not drawn into spout; ligament external; margin smooth; periostracum horny, extending beyond margin as fringe.....
..... SOLEMYACEA, Solemya velum, p. 82, fig. 50

Superfamily Nuculacea

Shells equivalve; mostly inequilateral with beaks in posterior half of valves in Nuculidae (Nucula), in anterior half in Nuculanidae (Yoldia). Ligament internal, dark brown, lying in chondrophore ventral and anterior to beaks in Nuculidae and ventral and slightly posterior in Nuculanidae. Siphons and pallial sinus lacking in Nuculidae; siphons and pallial sinus present in Nuculanidae.

Quick Reference Chart to Species Characteristics

	N. proxima	Y. limatula
Shell shape	obliquely ovate, inflated	elongate, compressed
Beaks	posterior half	anterior half
Teeth	12 anterior to ligament, 18 posterior	22 anterior to ligament, 18 posterior
Pallial sinus	lacking	wide, extending to beaks

Genus Nucula Lamarck, 1799

Nucula proxima Say, 1822 (Fig. 3)

Shell obliquely ovate, anterior nearly vertical; thick, strong, inflated; equivalve; inequilateral, beaks anterior to midline and directed anteriorly; up to 11 mm (9/20 inch) in length; color gray-green due to periostracum. Periostracum smooth, permanent, light olive green with darker areas. Ligament in very small pit

ventral to beaks. Sculpture slight concentric ridges and minute radiating lines; growth increments may be clear. Interior of shell pearl-white; sculpture lacking. Hinge plate moderately narrow with two series of teeth and sockets, nearly at right angles and separated by chondrophore; 12 teeth lying anterior to pit, 18 teeth lying posterior to chondrophore, including small teeth. Both adductor muscle scars prominent, subcircular. Pallial line moderately wide; pallial sinus lacking. Margin crenulate. Siphons lacking.

The Atlantic nut clam is common below the low water mark to offshore in fine sand to silty sand and mud where salinities are above 20 °/oo (Wass, 1965). In Virginia it is found from the lower York and James rivers to offshore.

RANGE: Nova Scotia to Texas.

Genus Yoldia Moller, 1832

Yoldia limatula (Say, 1831) (Fig. 4)

Shell asymmetrical, transversely ovate, elongate with posterior end pointed and gaping; firm, thin, compressed; equivalve; slightly inequilaterial, beaks not prominent, lying just anterior to midline; up to 64 mm (2½ inches, generally smaller in Virginia) in length; green-tan to light chestnut-brown in color. Periostracum glossy, light green with occasional darker areas and two or three lighter colored radiations. Ligament in small moderately projecting pit below beaks. Sculpture of fine, concentric lines indicating growth; growth increments clear. Interior of shell pale blue-white, pearly. Hinge plate with series of prominent teeth and sockets extending more than two-thirds length of shell; 22 teeth lying

anterior to ligament pit and 18 posterior. Posterior and anterior adductor muscle scars clear, subcircular. Pallial line clear; pallial sinus wide, rounded, extending to beaks. Margin smooth. Siphons united, white, fringed at openings.

Yoldia is a rather common shallow water species found below the low water mark in silty sand to mud where salinities are above 20 °/oo (Wass, personal communication). In Virginia it is rare to common in the lower James River and lower Chesapeake Bay.

RANGE: Maine to Chesapeake Bay; northern Alaska.

Superfamily Arcacea

Shell firm; mostly equivalve; inequilateral, beaks in anterior half. Ligament external, stretching across cardinal area exposed between beaks, latter may be widely separated. Hinge plate with numerous small alternating teeth and sockets (taxodont) not interrupted by a ligament. Adductor scars long, flared toward margins (trumpet-shaped), with muscle attached to ventral-most portion; anterior adductor smaller than posterior. Pallial sinus lacking.

Quick Reference Chart to Species Characters

	N. ponderosa	*A. transversa*	*A. ovalis*
Beak direction	posterior	central	anterior
Beak separation	wide	wide	narrow
External ribs	27-31, square with medial line	30-35, beaded	26-35, smooth square
Number of teeth	about 35	44-50	38-45
Muscle scars	elevated	impressed	impressed
Maximum length	65 mm	38 mm	59 mm
Byssus	red-purple, sheet-like	brown-black, threadlike	brown-black, threadlike

Genus *Noetia* Gray, 1857

Noetia ponderosa (Say, 1822) (Fig. 5)

Shell rectangularly ovate, posterior slightly wider and tapering; inflated, heavy; equivalve; inequilateral, umbones

subcentral in anterior half, beaks directed posteriorly and toward each other, widely separated; up to 65 mm (2½ inches) in length; color dirty white, flesh to sand-brown. Periostracum heavy, dark brown-black, worn from beaks. Ligament wide, black, spear-shaped band; beginning in posterior end as a thin line, rapidly expanding underneath beaks and then diminishing in anterior, extending across cardinal area in a number of relatively deep grooves. External sculpture of 25-38 square ribs, each with fine incised medial lines; growth increments clear. Interior of shell flat white to yellow-brown, muscle scars flat white, margins highlighted white; internal sculpture of shallow depressions radiating from umbones to margin ribs. Hinge straight, slightly expanded posterior to beaks; about 35 teeth, relatively straight posteriorly, shortest in center, chevron-shaped anteriorly. Adductor scars elevated. Pallial line clear. Margin scalloped with about 27 ribs. Siphons lacking.

The "ponderous ark" is common to abundant in fine sediment or mud. It is often attached by a strong, reddish-purple, sheet-like byssus to shells; on the Eastern Shore it is also attached to live Mercenaria (Chanley, personal communication). Noetia is unable to survive below 17.5 $^{o}/_{oo}$ salinities (Castagna and Chanley, personal communication) and is limited to the deeper waters and channels of lower Chesapeake Bay and Hampton Roads. It is common on the Eastern Shore subtidally and in channels.

RANGE: Virginia to Florida and Texas; fossil specimens common north of its range.

Genus Anadara Gray, 1847

Anadara transversa (Say, 1822) (Fig. 6)

Shell strongly rhomboidal-ovate, posterior slightly drawn out and deeper than anterior; moderately inflated, firm, heavy; slightly inequivalve, left valve extending slightly beyond right in posterior half; inequilateral, umbones subcentral in anterior half, beaks directed toward each other ventrally, widely separated; up to 38 mm (1½ inches) in length; color dirty white to light tan-brown. Periostracum, heavy, brown, hair-like, usually worn except along margins of valves. Ligament clearly distinct, moderately wide in a number of grooves extending lengthwise along cardinal area. External sculpture of 30-35 beaded ribs, 30-50 according to Hunter and Brown (1964); growth increments may be clear. Interior of shell white or pink between dull white scars and highlighted white margins; internal sculpture of fine radiating lines from umbo to margin. Hinge straight; 22-25 teeth in posterior half of hinge, appearing to fade in center just posterior to beaks, 22-25 teeth in anterior half. Adductor scars slightly impressed. Pallial line moderately wide and clear. Margin strongly scalloped, with about 26-29 ribs. Siphons lacking.

A. transversa lives subtidally in sand, mud or shell, or attached by a threadlike brown-black byssus to shells and pilings and is unable to survive below 10 $^{o}/_{oo}$ salinity. It is common in Chesapeake Bay and its lower tributaries and on the bay side of Eastern Shore, but does not occur on seaside (Chanley personal communication).

RANGE: South of Cape Cod to Florida and Texas.

Anadara ovalis (Bruguiere, 1792) (Fig. 7)

Shell ovate to roundly ovate; inflated, heavy; slightly inequivalve left valve extending beyond right in posterior half; inequilateral, umbones in anterior third of shell; beaks directed anteriorly, then ventrally, closely spaced; up to 59 mm (2⅓ inches) in length; color dirty white to light cocoa-brown. Periostracum dark brown-black, worn from umbones in adults. Ligament a depressed black band in faint adjacent grooves extending across cardinal area. External sculpture of 26-36 smooth, square radiating ribs; growth increments clear. Interior of shell dull white or light straw-yellow between dull white scars and shiny white margins; internal sculpture of fine lines radiating from umbo to margin. Hinge slightly curved; 30-35 teeth, consecutive, straight, covering three-fourths of hinge, a few chevron-shaped; about 8-10 deformed teeth isolated in anterior fourth, hinge slightly expanded in this area; adductors slightly impressed. Pallial line obscure. Margin with about 29-33 heavy ribs. Siphons lacking.

This "blood clam" is usually found subtidally, rarely intertidally, and may be in mud and sandy silt or attached by a threadlike brown-black byssus to shells and pilings; it is not found at salinities below 15 $^{o}/_{oo}$. It is less common in the lower Chesapeake Bay than A. transversa; on the Eastern Shore it occurs in bays, channels and salt marshes on seaside, but is less common than Noetia.

RANGE: Cape Cod to West Indies (Puerto Rico) and the Gulf States (Warmke and Abbott, 1961).

Superfamily Mytilacea

Shell equivalve; inequilateral, beaks in anterior half, often at or close to anterior end. Periostracum prominent, closely adhering. Ligament external in Virginia species, may be deeply inset and concealed. Hinge line lacking teeth, but may have tooth-like crenulations. Adductor scars usually markedly unequal (heteromyarian), anterior smaller. Retractor muscle scars well-defined. Pallial sinus lacking.

Quick Reference to Species Characteristics

Ribbed species	*B. recurvus*	*M. demissus*
Shell description	spatulate, recurved; wavy ribs	elongate-triangulate; bifurcate ribs
Crenulations	3-4 small, elongate	lacking
Maximum length	64 mm	134 mm
Non-ribbed species	*M. edulis*	*A. papyria*
Shell description	triangular-ovate, firm	elongate, fragile
Umbones	at anterior tip	near anterior end
Crenulations	3-12, small	lacking
Color	pale blue, blue-black, brown	gray to yellow-brown with red-brown cobweb design

Genus Brachidontes Swainson, 1840

Brachidontes recurvus (Rafinesque, 1820) (Fig. 8)

Shell spatulate in outline, broad, anterior end hooked; moderately thin, compressed posteriorly; equivalve; inequilateral, umbo near, but not at anterior tip of each valve; up to 62 mm (2½ inches, rarely over 1-1½ inches in Virginia) in length; dark gray-black in color. Periostracum shiny, varnish-like. External ligament long, dark gray-black band. Byssal cleft wide; shell curves viscerally. Sculpture numerous wavy axial ribs; growth increments clear. Interior of shell lavender to rose-brown, iridescent, with narrow blue-gray border; sculpture lacking. Hinge with 3-4 very small, elongate crenulations on shell edge near umbones. Posterior adductor large, circular in outline; anterior adductor elongate, extremely small, thin, both scars rose-violet in color. Posterior retractor scar very thin, elongate, lying anterior to posterior adductor; anterior retractor scar extremely small, lavender, lying below ligament. Pallial line light lavender, irregular on visceral edge. Margin crenulate. Siphons lacking.

The hooked mussel is very common on subtidal oyster beds. It is found at minimum water salinities between 2.5-6 $^{o}/oo$, but seldom survives predation where salinities are above 15-25 $^{o}/oo$ (Andrews, personal communication).

RANGE: Rhode Island to Texas and the West Indies (Johnson, 1934); rare north of Chesapeake Bay where it may have been introduced locally with imported oysters.

Genus Modiolus Lamarck, 1799

Modiolus demissus (Dillwyn, 1817) (Fig. 9)

Shell elongate-triangulate; heavy, thick, inflated; equivalve; inequilateral, beaks near anterior end; up to 134 mm (5¼ inches) in length in southeastern salt marshes, but usually less than four inches in other areas or substrates; black-brown, brown or yellow-brown in color, often shiny. Periostracum yellow-green or brown in color, thin, varnish-like. Ligament mostly concealed, strong, extending beyond midline. Byssal cleft small. Sculpture strong, rough, raised, bifurcating ribs (umbones and anterior of shell highly eroded in marsh areas). Growth increments clear. Interior of shell light blue-white; posterior iridescent, flushed with purple or red-purple; sculpture lacking. Hinge area lacking crenulations. Posterior adductor scar large, nearly subcircular; anterior adductor scar moderately large, ovate. Posterior retractor scar small, elongate, thin, lying anterior to and continuing with posterior adductor; anterior retractor scar moderately large, impressed, lying ventral to ligament in anterior end. Pallial line moderately thin. Margin crenulate on posterior third of shell where external ribs meet margin. Siphons lacking.

The ribbed mussel is abundant in Chesapeake Bay and on the Eastern Shore. It lives high intertidally (higher than any other Virginia bivalve) attached to a variety of substrates, and is commonly found in salt marshes almost entirely buried, at all salinities above 8-10 °/oo (Andrews, 1953).

RANGE: Gulf of St. Lawrence to South Carolina; introduced to California.

Genus Mytilus L., 1758

Mytilus edulis L., 1758 (Fig. 10)

Shell triangular-ovate; thin, firm, moderately inflated; equivalve; inequilateral, umbones at anterior tip; up to 229 mm (9 inches, maximum about 2-3 inches in Virginia) in length in Europe (Tebble, 1966); pale blue, blue-black or brown in color. Periostracum nearly black, dark brown or olive. External ligament mostly concealed, extending from beaks almost to highest point of shell. Byssal cleft small. Sculpture smooth, fine concentric lines; growth increments clear. Interior of shell pearl-white with wide border of purple or dark blue; sculpture lacking. Hinge line with 3-12 small crenulations under the umbones (Tebble, 1966). Anterior adductor scar small, elliptical; posterior large, circular in form; both often colored dark blue-black. Posterior retractor muscle scar large, expanded, linear in form, often dark blue-black, lying just anterior to posterior adductor; anterior retractor impressed, very small, colorless, lying on dorsal edge below ligament. Anal muscle scar small, triangular, lying just posterior to posterior adductor (Field, 1921). Pallial line wide, visceral border irregular in outline. Margin smooth. Siphons lacking.

The edible blue mussel is a circumboreal cool-water species. This species can survive salinities as low as 4-6 $^{o}/oo$, but salinities higher than 15 $^{o}/oo$ may be necessary for optimum physiological functioning (Castagna and Chanley, personal communication). Summer temperatures in Virginia limit its distribution where salinities are greater than 15-18 $^{o}/oo$ (Andrews, 1956). Permanent populations

of these mussels are found in the lower Chesapeake Bay, inlets on the sea side of the Eastern Shore and in the mouth of the Bay, attached to hard substrates (pilings, wharves and rocks). Small mussels are abundant in other areas seasonally.

RANGE: Arctic Ocean to South Carolina, California, the Mediterranean and Japan; absent from the high Arctic (Tebble, 1966).

Genus Amygdalum Megerle von Muhlfeld, 1871

Amygdalum papyria (Conrad, 1846) (Fig. 11)

Shell elongate; smooth, fragile, moderately compressed; equivalve; inequilateral, beaks near anterior end, directed anteriorly; up to 30 mm (1¼ inches) in length; shiny, iridescent gray to yellow-brown, colored with fine, red-brown cobweb design. Periostracum thin, varnish-like. Ligament external, weak, thin, extending from beaks posteriorly to near highest point of shell. Sculpture of fine concentric growth lines; growth increments usually unclear. Interior of shell iridescent-white, external cobweb design visible; sculpture of occasional, fine, growth lines. Hinge line lacking crenulations. Posterior adductor muscle scar subcircular; anterior adductor scar small, linear. Posterior retractor scar thin, long, lying anterior to and continuous with posterior adductor scar; anterior retractor scar inconspicuous or absent. Anal muscle scar large, triangular, just ventral to posterior adductor scar. Pallial line wide, expanded between anal muscle scar and anterior adductor scar. Margin smooth. Siphons lacking.

In Virginia the paper mussel is a scarce to common inhabitant of sand and eel grass beds where it is imbedded in its byssus nest. This euryhaline species has been found where salinities are between 10 °/oo (Wass, personal communication) and 45 °/oo (Parker, 1960).

RANGE: Virginia to the Gulf of Mexico.

Superfamily Pectinacea

Shells usually inequivalve; inequilateral with asymmetrical projections or ears about beaks, byssal notch in anterior ear of right valve. Ligament internal, in central triangular pit ventral to beaks. Hinge without teeth, taxodont in young stages. Each valve with one muscle scar (monomyarian).

Genus Aequipecten P. Fischer, 1887

Aequipecten irradians (Lamarck, 1819) (Fig. 12)

Shell circular, except for projecting ears; strong, moderately inflated; inequivalve, ears unequal, left valve (upper) slightly more convex than right; up to 75 mm (3 inches) in length; color variable, may be dusky, black, slate, orange, purple, red-brown, or white. Periostracum lacking. Internal ligament strong, attached to triangular pit ventral to beaks. Sculpture 12-21 low, square, radial ribs and coarse, closely-spaced, concentric, undulating growth lines, often worn on ribs. Growth increments unclear. Interior of shell white or gray, left valve margin often tinged with red to black-brown; internal sculpture deep, smooth, radiating ridges. Hinge straight, drawn into projecting ears; teeth lacking. Muscle scar slightly posterior to midline, not impressed. Margin deeply scalloped where ridges meet ventral border. Siphons lacking.

The common Atlantic bay scallop is an inhabitant of eel

grass in bays where salinities are above 30 °/oo. This species was once abundant in Eastern Shore lagoons, but since the disappearance of the eel grass it has become rare.

RANGE: Nova Scotia to North Florida; along the Gulf to Texas.

Superfamily Anomiacea

Shell irregular in outline; inequivalve; inequilateral beaks and umbones not prominent, near midline. Attached by calcified byssus passing through aperture near umbo of right lower valve. Internal ligament attached along hinge line. Hinge lacking teeth or ridges. Each valve with one adductor muscle scar only (monomyarian); left valve with one or two byssus muscle scars close to adductor. Pallial line lacking.

Genus Anomia L., 1758

Anomia simplex Orbigny, 1845 (Fig. 13)

Shell irregular in shape and outline, tending to be circular; thin, right valve fragile, left valve strong, usually moderately compressed, but variable; inequivalve, right valve smaller and flatter than more convex left valve; inequilateral; up to 51 mm (2 inches) in length; translucent, yellow, dull orange or tan in color. Periostracum lacking. Internal ligament short, thick; ligament pit in left valve linear. Byssal aperture irregularly oval. Sculpture scaly, lamellar, often encrusted with fouling organisms; both valves frequently assume sculpture of object to which right valve is attached. Growth increments unclear. Interior of shell glossy to pearly, dull orange, yellow, or black if buried in mud, some with silver sheen; sculpture of slightly raised concentric undulations. Each valve with one large adductor muscle scar; left valve with

single adductor scar divided into three scars, larger scar dorsal, with two small ventral scars. Margin jagged or undulating. Siphons lacking.

The common jingle lives attached to various solid substrates (shells, rocks, logs, boats) below the low water mark where salinities are above 10 $^{o}/oo$. It is abundant in Virginia on shell substrates.

RANGE: Novia Scotia to the West Indies (Johnson, 1934).

Superfamily Ostreacea

Shell heavy; inequivalve; inequilateral, beaks and umbones inconspicuous; left (lower) valve attaching animal to substrate, normally larger, generally convex and often deeply cupped, right valve tending to be flat. Ligament internal. Hinge line lacking teeth in adult. Single adductor muscle scar positioned with center posterior to midline.

Genus *Crassostrea* Sacco, 1897

Crassostrea virginica (Gmelin, 1792) (Fig. 14)

Shell broadly oval in outline, often distorted and irregular (shape influenced by substrate and environment); heavy, thick; inequivalve, left valve deeply cupped, thicker than right, right valve slightly concave; inequilateral, beaks located at anterior end, inconspicuous; up to 357 mm (14 inches, usually 3-5 inches in Virginia) in dorsoventral height (Galtsoff, 1964); white or gray in color, young frequently with brown or purple rays. Periostracum thin, dark brown. Ligament internal, attached to central triangular pit, with lateral extensions. Sculpture of irregular shelves or fringes of shell formed from prolific production of internal shell layers; irregular radiating ribs in left valve. Interior of shell white; sculpture slight concentric ridges. Hinge line lacking teeth. Adductor muscle scar well toward posteroventral border, impressed, subcircular, often with deep purple or red-brown curved bands.

Margin smooth. Shape, sculpture and pigmentation vary greatly. Siphons lacking.

The eastern or Atlantic oyster is a euryhaline species tolerating salinities from 5-30 °/oo, although occasionally killed by freshets at the low extreme of this range. It requires hard substrates, such as shells, pilings or rocks to settle on. This oyster has been found at winter temperatures of -2 C in northern states and maximum temperatures of about 36 C in southern states. This commercially important species has been excellently reviewed by Galtsoff (1964). Oysters are abundant in Chesapeake Bay and Eastern Shore.

RANGE: Gulf of St. Lawrence to the Gulf of Mexico and the West Indies; introduced to San Francisco Bay, Puget Sound and Britain (Tebble, 1966).

Superfamily Corbiculacea

Shell equivalve and inequilateral. Periostracum present. Ligament external. Hinge line with three cardinal teeth in either valve and smooth or serrate lateral teeth. Adductor muscle scars about equal. Brackish water species (Keene, 1958).

Genus Polymesoda Rafinesque, 1828

Polymesoda caroliniana Bosc, 1830 (Fig. 15)

Shell subtriangular; strong, moderately thick, inflated; equivalve; slightly inequilateral, beaks just anterior to midline and directed anteriorly; up to 48 mm (1 7/8 inches) in length; brown. Periostracum fuzzy or minutely scaled, glossy brown, thin. External ligament strong, long, narrow, deeply inset, dark brown. Sculpture concentric undulating growth lines; growth increments clear. Interior of shell white, often stained with iridescent purple; sculpture lacking. Both valves with three cardinal teeth; two bifid cardinals in each valve, anterior two in left, posterior two in right. Left valve with two large, knoblike laterals, one anterior, and one posterior. Right valve with two distinct laterals, one anterior and one posterior; two deep fossae lying dorsal to laterals and receiving laterals of left valve; and two obsolescent knoblike laterals lying dorsal to fossae. Pallial line moderately narrow; sinus narrow, fairly deep. Margin smooth. Siphons short, separate, often pigmented

(Vander Shalie, 1933).

This marsh clam is common in intertidal mud or rock-shell at the mouths of rivers where the influence of the tides is felt and salinities are less than 10 $^{o}/_{oo}$; but it is not found in freshwater (Castagna and Chanley, personal communication). In Virginia it is restricted to intertidal habitats in the James River from Deep Creek to just west of Jamestown Island (Andrews and Cook, 1951).

RANGE: Virginia to North half of Florida and Texas.

Superfamily Dreissenacea

Shells similar to Mytilus in shape. Hinge margin excavated; single tooth obsolete, triangular, cup-shaped process located beneath septum and projecting into shell cavity. Brackish to freshwater species.

Genus Congeria Partsch, 1835

Congeria leucophaeata (Conrad, 1831) (Fig. 16)

Shell elongate-triangular, ventral side depressed; firm, inflated; equivalve; inequilateral, beaks at anterior end; up to 19 mm (3/4 inch) in length; blue-white to tan. Periostracum moderately glossy, roughened into slightly raised ridges at growth lines, gray-brown in color. Ligament long, thin, strong, deeply inset. Byssal aperture narrow. Sculpture concentric, irregular, slightly raised growth lines; growth increments may be clear. Interior of shell blue-tan; sculpture faint, concentric impressions. Hinge with flat, white, calcareous, internal septum located in anterior end; tiny, downwardly projecting triangular process located posteriorly beneath septum. Posterior adductor muscle scar moderately small, subcircular; anterior adductor muscle scar small, elongate. Pallial line moderately narrow. Margin smooth. Siphons lacking.

This common brackish water bivalve attaches itself by its short byssus to solid substrates such as rocks, twigs, and buoys in clumps

which resemble Mytilus colonies in brackish to freshwater. In Virginia it is common below 10 °/oo (Andrews, 1956) attached to phanerogams and oyster shells.

RANGE: New York to Texas and Mexico.

Superfamily Lucinacea

Shell equivalve and slightly inequilateral. Ligament external, may be so deeply inset as to appear internal. Hinge line with cardinal and/or lateral teeth. Anterior adductor scar sometimes larger than posterior. Pallial line lacking sinus.

Genus Lucina Bruguiere, 1797

Lucina multilineata Tuomey and Holmes, 1857 (Fig. 17)

Shell subcircular; obese, moderately thick; equivalve; slightly inequilateral, beaks just anterior to midline and directed anteriorly; up to 6 mm (¼ inch) in length; white. Periostracum brown, very slight. External ligament deeply inset. Sculpture very fine concentric growth lines and fine, threadlike radial ribs. Growth increments clear. Interior of shell white; sculpture fine radiating lines and occasional fine concentric lines. Left valve with two small cardinal teeth, one anterior to large fossa, one posterior; laterals lacking, one anterior fossa near anterior margin, one posterior fossa near posterior border. Right valve with one large triangulate tooth fitting into cardinal fossa of left valve; one anterior lateral and one posterior lateral, both modified to large knobs and fitting into lateral fossa of left valve. Anterior adductor muscle scar larger than posterior. Pallial line wide. Siphons lacking.

Lucina is common from the intertidal to 240 meters where salinities

are above 25 °/oo. Chanley and Castagna (personal communication) established the lower salinity limit for survival at 7.5 °/oo under laboratory conditions. In Virginia it is found in lower Chesapeake Bay in sandy silt where salinities are about 20 °/oo.

RANGE: Chesapeake Bay to both sides of Florida.

Superfamily Erycinacea

Shell equivalve; mostly inequilateral. Periostracum not prominent. Principal element of ligament internal, ventral and posterior to beaks; small tensilium sometimes present. Hinge line normally with teeth. Adductor muscle scars subequal. Pallial sinus lacking. Margin smooth.

Quick Reference to Species Characteristics

	A. elevata	M. bidentata
Shell shape	triangularly ovate	oval
Teeth	two cardinals in each valve; laterals lacking	cardinals lacking; two laterals in each valve appearing as projections of hinge line
Habitat	commensal with Clymenella	commensals not known for Virginia

Genus Aligena Lea, 1843

Aligena elevata Stimpson, 1851 (Fig. 19)

Shell triangularly ovate; fragile, moderately compressed; equivalve; slightly inequilateral, beaks prominent, inflated, lying just posterior to midline and directed toward each other; up to 5 mm (¼ inch) in length; glossy white. Periostracum thin, straw-colored. Internal ligament lying on excavated posterior cardinal tooth. Sculpture fine, concentric growth ridges; growth increments inconspicuous. Interior of shell glossy white; sculpture faint radiating

lines. Both valves with two cardinal teeth diverging from beaks with triangular vacancy between; anterior cardinal raised and prominent, posterior cardinal reduced, excavated and receiving the ligament; laterals lacking. Adductor muscle scars sub-oval. Pallial line wide, slightly corrugated. Margin smooth. Siphons lacking.

Little is known about Aligena, except that it is commensal with Clymenella. It is fairly common in Virginia below the low water mark.

RANGE: Massachusetts (Gould, 1870) to Virginia (Wass, 1965).

Genus Mysella Angas, 1877

Mysella bidentata (Montagu) (Fig. 20)

Shell oval; fragile, fairly compressed; equivalve; inequilateral, beaks in posterior half directed toward each other, almost touching; up to 5 mm (nearly ¼ inch) in length; white, sometimes translucent. Periostracum light brown. Ligament internal, ventral and posterior to beaks. Sculpture of fine concentric lines; growth increments may be clear. Interior of shell white or translucent, smooth; sculpture lacking. Cardinal teeth lacking; two prominent laterals in right valve, one anterior and one posterior; two laterals in left valve, appearing as projections of hinge line. Adductor scars subequal. Pallial line wide. Margin smooth. Siphons lacking.

According to Jenner (personal communication), Mysella planulata Stimpson, 1857 is the same species as the European M. bidentata. Tebble (1966) says Mysella principally inhabits muddy sand and gravel, but has been found in the crevices of old oyster shells, in the burrows of Golfingia, a sipunculid, and associated with Acrocnida brachiata, an ophiuroid, from very low in the intertidal zone to

120. 7 meters offshore. Jenner (personal communication) finds Mysella living commensally on brittle stars. Abbott (1954) states it is moderately common attached to buoys, eel grass and wharf pilings. Wass (1965) cites Mysella as occurring off the Rappahannock River.

RANGE: Nova Scotia to Texas and the West Indies; Iceland and northern Norway south to the Iberian Peninsula, Mediterranean and Black seas, Madeira, Azores, along the coast of northwest Africa to Portuguese Guinea (Tebble, 1966).

Superfamily Cardiacea

Shell inflated, equivalve and inequilateral. Ligament external, prominent dark brown arched band behind beaks. Hinge line with teeth that curve out rather than being set in flat plate; two cardinal teeth in each valve; two anterior and one or two posterior laterals in right valve, one anterior and one posterior in left. Pallial sinus lacking.

Genus Laevicardium Swainson, 1840

Laevicardium mortoni (Conrad, 1830) (Fig. 18)

Shell obliquely triangulate to ovate; light, thin, inflated; equivalve; inequilateral, umbones high, beaked just anterior to mid-line; up to 25 mm (1 inch) in length; glossy, dirty white to fawn in color, commonly with patterns of brown zig-zag markings. Periostracum yellow-green or brown, thin, but heavier on anterior and posterior slopes, glossy. Ligament posterior to beaks, long, strong. Lunule and escutcheon not defined. Sculpture fine concentric ridges, minutely papillose on most specimens. Interior of shell smooth, variable in color, generally yellow with a deep purple patch on posterior end; sculpture of fine, smooth, radiating ribs. Left valve with two cardinal and two lateral teeth; posterior lateral and cardinal rudimentary and inconspicuous, anterior prominent. Right valve with two cardinal and two lateral teeth, one anterior lateral and one posterior lateral.

Adductor muscle scars subequal. Margin crenulate. Siphons lacking.

The duck clam, a food of wild ducks, lives intertidally to a depth of four meters in sand, silty sand, and occasionally in eel grass. It is fairly common from 15-25 °/oo and occasionally abundant in some areas of Chesapeake Bay and its tributaries. According to Castagna and Chanley (personal communication) Laevicardium has a lower salinity limit of 7.5 - 10 °/oo.

RANGE: Massachusetts to Guatemala (Clench and Smith, 1944).

Superfamily Veneracea

Most species with shell hard; equivalve; inequilateral; beaks central or antero-central, directed anteriorly and toward each other; escutcheon and lunule distinct. Ligament external elliptical band, well-developed, often deeply inset. Sculpture concentric and radial. Hinge plate with two or three cardinal teeth in each valve; lateral teeth lacking or vestigial in left valve. Muscle scars subcircular and about equal. Pallial line indented with a sinus.

Quick Reference to Distinguish Similar Venerids

Compressed species	*D. discus*	*C. tenuis*
Shell	glossy, compressed	dull, moderately compressed
Shape	subcircular	circular
Sculpture	fine, concentric ridges (20/cm)	irregular growth lines
Lunule	short, well-defined	long, poorly defined

Inflated species	*M. mercenaria*	*P. morrhuana*
Lunule	heart-shaped	nearly round
Laterals	lacking	left anterior lateral knoblike
Sinus	shallow	deep
Margin	crenulate	smooth

Genus Dosinia Scopoli, 1777

Dosinia discus Reeve, 1850 (Fig. 21)

Shell subcircular; fragile, compressed; beaks slightly anterior to midline, directed anteriorly; up to 90 mm (3½ inches) in length; glossy, dirty white, straw-yellow, fawn or light brown in color. Periostracum yellow. Ligament deeply inset, extending two-thirds of way to posterior margin. Lunule short, well-defined, moderately impressed, heart-shaped with fine radiating ridges. Escutcheon narrow, weakly defined, posterior to ligament. Sculpture fine, circular, concentric ridges, about 20 per cm in central portion of disk in adults; another species, D. elegans, has about 10 ridges per cm (Clench, 1942). Hinge plate broad. Three cardinal teeth in each valve; posterior cardinal bifid in right valve; anterior lateral tooth small and knob-like in left valve, fitting into shallow depression in right. Interior of shell flat white; muscle scars and free margin shiny; sculpture lacking. Pallial sinus triangular, deep; apex directed toward anterior muscle scar, with a somewhat rounded point. Siphons united, narrow, long.

Dosinia occurs from low intertidal to subtidal, deep in sand or mud. It is a high salinity species (greater than 25 °/oo) that is rare at Virginia Beach and on the seaside of the Eastern Shore. Hinged paired valves and one recently dead specimen have been taken in the lower Chesapeake Bay.

RANGE: Cape May, New Jersey to Yucatan.

Genus Cyclinella Dall, 1902

Cyclinella tenuis Recluz, 1852 (Fig. 22)

Shell circular, extremely fragile, thin, moderately compressed; equivalve; inequilateral, umbones anterior to midline, beaks directed anteriorly; maximum length of four Virginia specimens 45 mm (1 3/4 inches); color dull flesh to yellow. Periostracum thin, straw-yellow. Ligament deeply inset dark band. Lunule long, poorly defined, not impressed. Escutcheon lacking. Sculpture numerous, irregular growth lines. Valves each with three cardinal teeth; posterior cardinal in right valve bifid, central cardinal in left valve large, triangular. Lateral teeth lacking. Interior of shell flat white to flesh, margin glossy; sculpture lacking. Pallial sinus deep, apex rounded, reaching to midline, directed toward lunule. Margin smooth. Siphons united, narrow, moderately long.

This clam is extremely rare in Virginia. Two specimens were taken in the York River, one off VIMS pier at 8 meters and another near Yorktown; a third off the mouth of the Rappahannock in the Chesapeake Bay; the fourth from a shell pile in Willis Wharf, Eastern Shore. Salinity tolerance and typical habitat are not known.

RANGE: Virginia to the Gulf of Mexico and the West Indies [extended from North Carolina (Warmke and Abbott, 1961)].

Genus Mercenaria Schumacher, 1817

Mercenaria mercenaria (L., 1758) (Fig. 23)

Shell subtriangular to roundly ovate, posterior half narrower and slightly drawn out; heavy, inflated; equivalve; inequilateral, umbones prominent in anterior third of shell, beaked anteriorly and directed toward each other, nearly touching; rarely more than 127 mm (5 inches) in length; color white, dull gray or straw-yellow to flesh tones. Lunule conspicuous, heart-shaped. Escutcheon indistinct. Periostracum often worn and inconspicuous, fawn to chocolate-brown. Ligament dark brown, posterior to beaks and reaching halfway to posterior margin. Sculpture of strong concentric ridges and radiating ribs, center of valves often worn smooth; growth increments prominent. Interior of shell flat white or blue-violet in color; sculpture lacking. Three teeth in each valve, left with anterior tooth large and posterior bifid; right with large posterior tooth and two oblique contiguous teeth; rough irregular points below hinge interlocking with those of opposite valve; laterals lacking. Muscle scars subcircular and impressed, often having colored sculpture. Sinus triangular, shallow, apex directed toward ventral portion of anterior muscle scar. Margin crenulate. Siphons short and united.

The hard clam or quahog is found abundantly in a wide variety of substrates intertidally to channel depths. In Virginia it is found where salinities are above 15 ^{o}/oo; under laboratory conditions, Chanley (1958) states 12.5 ^{o}/oo is the lower survival limit.

The form M. notata is rarely found in Virginia. It coexists

with M. mercenaria mercenaria in the same habitat. The shell is shiny, white, tinged with sand-brown and with red-brown zig-zag marks; the surface is almost smooth.

RANGE: Nova Scotia to the Gulf of Mexico; introduced to California, United Kingdom, Netherlands, Belgium and France (Tebble, 1966).

Mercenaria campechiensis (Gmelin, 1792)

Distinguishing features from M. mercenaria are: shell thicker, heavier and more obese; up to 168 mm (8½ inches) in length (Sims, 1965); growth ridges deeper and retained longer in young specimens; color white, rarely with blue or violet stain on escutcheon and brown zig-zag lines on the side. Lunule usually as wide as long. Internal color usually white.

The southern quahog is uncommon in Virginia and exists only in the lower reaches of the Bay and offshore.

RANGE: New Jersey (offshore) to Cape Canaveral and the Gulf of Mexico (Abbott, 1954).

Genus Pitar Romer, 1857

Pitar morrhuana (Linsley, 1848) (Fig. 24)

Shell subovate; heavy, thick, inflated; equivalve inequilateral, umbones in anterior half, beaks directed anteriorly and ventrally; up to 50 mm (2 inches) in length; chalky white in color. Periostracum rust to gray-brown, frequently with agglutinated grains of substrate over marginal fourth of shell. External ligament broad, dark, deeply inset band. Lunule well-defined, long, wide, shallow spade-shaped; sculpture of numerous heavy lines of clear, growth increments. Interior of shell white; sculpture lacking. Three cardinal teeth in each valve, left valve with anterior lateral knoblike, fitting into socket in right, laterals lacking in right; anterior and median cardinal teeth Λ-shaped in left valve; posterior and anterior cardinal Λ-shaped with central cardinal large and pointed in right valve. Pallial line wide and irregularly corrugated; sinus moderately deep, triangulate, apex directed toward anterior adductor. Margin smooth. Siphons united, moderately long.

In Virginia this clam is found in mud or broken shell substrates. Its salinity tolerance is unknown. Juveniles are scarce and adults rare in seaside bays and inlets, but are common offshore. It has not been taken in Chesapeake Bay.

RANGE: Prince Edward Island to Cape Hatteras, North Carolina.

Genus Gemma Deshayes, 1853

Gemma gemma (Totten, 1834) (Fig. 25)

Shell globose or subtrigonal; thin, moderately inflated; equivalve; nearly equilateral, beaks near midline directed posteriorly and ventrally; up to 3 mm (1/8 inch) in length; shiny white to fawn color, often with red-blue or purple patch, rarely entirely purple. Periostracum inconspicuous or absent. Ligament short, golden brown band. Lunule indistinct, faintly impressed. Escutcheon lacking. Sculpture of fine concentric lines, frequently eroded about umbo. Interior of shell white; sculpture lacking. Three cardinal teeth and two low laterals in each valve; posterior cardinal of left valve and anterior of right cardinal thin, not easily distinguished, median cardinal of each valve robust, triangular, anterior left and posterior right cardinal thin, distinct. Pallial sinus acutely angled, apex directed toward beaks. Margin crenulate. Siphons short, united, one shorter, one frequently brown.

The amethyst gem clam is a common inhabitant of sand shores and tidal flats in shallow water having salinities from 5-30 $^{o}/_{oo}$. Specimens are common to patchily abundant in the Chesapeake Bay.

RANGE: Nova Scotia to Florida, Texas and the Bahamas; introduced to Puget Sound, Washington.

Genus Petricola Lamarck, 1801

Petricola pholadiformis (Lamarck, 1818) (Fig. 26)

Shell elongate-oval (shape variable with habitat); thin, brittle, inflated; equivalve; inequilateral, beaks in anterior third directed ventrally and toward each other; up to 64 mm (2½ inches) in length; color dull white to fawn. Periostracum dark brown. Ligament prominent arched band extending fourth of way from beaks to posterior margin. Lunule not well defined, broadly elliptical. Escutcheon lacking. Sculpture of 40 or more radiating ribs and numerous fine concentric lines; anterior ribs large, coarse, with prominent spatulate spines. Growth increments may be clear. Right valve with two protruding, pointed, cardinal teeth, posterior bifid; left valve with three, long, pointed cardinal teeth, median bifid. Laterals lacking. Interior of shell white; sculpture of ribs and occasional concentric lines. Pallial sinus deep, extending beyond midline. Margin crenulate where large ribs extend to margin, elsewhere smooth. Siphons translucent, gray, large, tubular, separated almost down to bases.

Petricola is a common intertidal, mechanical borer into peat, stiff mud or limestone in waters having salinities of 20-35 °/oo. Large specimens (a recent shell measured two inches) are taken by dredge offshore; smaller specimens are taken on Eastern Shore; and small, long, narrow specimens are taken at Tue Marsh light, York River. Short, thick, and stunted specimens, often with deformed teeth, are taken in Mytilus beds among the byssus threads.

RANGE: Prince Edward Island to the Gulf of Mexico, California, South Norway to the Mediterranean and Black seas, along the coast of West Africa to Senegal and the French Congo (Tebble, 1966).

Superfamily Tellinacea

Shells mostly equivalve, posterior twist in both valves may produce inequivalve condition; mostly inequilateral, beaks normally in posterior half. Ligament external. Normally two cardinal teeth in each valve, but one of these may be lacking; lateral teeth often present and distinct, may appear only as inward extensions of doral line. Adductor muscle scars about equal; cruciform muscle scars usually present and concerned with extension and retraction of siphons; pallial sinus deep.

Quick Reference Chart to Species Characteristics

	T. agilis	*M. balthica*	*M. phenax*	*M. tenta*
Shell shape	suboval anterior pointed and not gaping	broadly ovate not gaping	suboval, gaping slightly	oval-elongate posterior truncate and gaping
Teeth	two cardinals in each valve, distinct anterior lateral in right valve	two cardinals in each valve, laterals lacking	two cardinals in each valve, laterals lacking	two cardinals in each valve laterals lacking
Pallial sinus	equal in size in each valve, extending nearly to anterior adductor	extending further toward anterior adductor in right valve	extending further toward anterior adductor in left valve	extending further toward anterior adductor in left valve

Quick Reference Chart to Species Characteristics

	A. aequalis	D. variabilis	T. plebeius
Shell shape	subcircular, not gaping	wedge-shaped, not gaping	oblong, anterior truncate and gaping
Teeth	two cardinals in each valve obsolete anterior lateral in right valve	two cardinals and two laterals in left valve, one cardinal and two laterals in right valve	two cardinals in each valve laterals lacking
Pallial sinus	equal in size in each valve extending nearly to anterior adductor	equal in size extending to midline	equal in size extending to midline

Genus Tellina L., 1758

Tellina agilis Stimpson, 1858 (Fig. 28)

Shell sub-oval, moderately elongate, anterior pointed; thin, moderately fragile, compressed; equivalve; inequilateral, beaks posterior to midline; up to 13 mm (½ inch) in length; glossy white tinged with pink. Periostracum lacking. External ligament short, prominent. Sculpture fine, concentric evenly spaced lines; growth increments may be clear. Interior of shell white, glossy; sculpture fine, occasional, concentric impressions. Hinge plate moderately narrow, two cardinal teeth in each valve; anterior cardinal bifid in left valve, posterior cardinal bifid in right; right valve with anterior lateral distinct, thin. Adductor muscle scars distinct, subequal; cruciform muscle scars indistinct. Pallial line moderately narrow, indistinct; pallial sinus wide, deep, nearly touching anterior

adductor scar and confluent with pallial line. Margin smooth. Siphons long, narrow, separate.

Tellina agilis is common in fine or muddy sand on intertidal flats and in shallow water. In Virginia it is common to abundant where salinities are above 18 °/oo.

RANGE: Gulf of St. Lawrence to North Carolina.

Genus Macoma Leach, 1819

Macoma balthica (L., 1758) (Fig. 27)

Shell broadly ovate, somewhat narrower posteriorly; thin, firm, moderately compressed with anterior moderately inflated; nearly equivalve, posterior slightly twisted to right; nearly equilateral, beaks central or just posterior to midline; directed toward each other; up to 38 mm (1½ inches, usually smaller in Virginia) in length; color white, tinged with pale yellow, pink or purple. Periostracum thin, colorless or pale brown or gray. External ligament prominent, extending third of way to posterior margin. Sculpture very fine concentric lines, surface appearing smooth; growth increments clear. Interior of shell white, purple or shade of external color; sculpture of faint, concentric lines, representing growth increments. Hinge plate elongate, two small cardinal teeth in each valve; anterior cardinal of left valve and posterior cardinal of right bifid; laterals lacking. Anterior adductor muscle scar narrower than posterior, may be discolored; cruciform muscle scars sometimes clear. Pallial line moderately wide, irregular; pallial sinus deep, lower border confluent with pallial line, extending further toward anterior muscle scar in right valve.

Margin smooth. Siphons long, separate, white.

This species is a common intertidal and deep water species which inhabits thick organic mud, muddy sand or gravel and occasionally sand. In Virginia it is abundant intertidally to 10 meters where salinities are between 5-15 °/oo; under laboratory conditions Castagna and Chanley (personal communication) extended this range to 2.5 - 30 °/oo.

RANGE: Artic Sea to Georgia; White Sea to the Iberian Peninsula; Bering Sea to Monterey, California (Abbott, 1954; Tebble, 1966).

Genus Macoma Dall, 1900

Macoma phenax Dall, 1900 (Fig. 29)

Shell sub-oval, posterior and anterior slightly drawn out and rounded slightly gaping; thin, fragile, compressed; equivalve; inequilateral, beaks just posterior to midline, directed posteriorly, up to 15 mm (over 3/4 inch) in length; vitreous, white. Periostracum thin, shiny pale cream in color. External ligament moderately strong, short, posterior to beaks, yellow-brown. Sculpture fine concentric lines; growth increments clear. Interior of shell glossy, white; sculpture fine concentric lines and radial striations. Hinge plate narrow, both valves with two cardinal teeth, laterals lacking; anterior cardinal bifid and posterior rudimentary in left valve, anterior cardinal strong and posterior bifid in right valve. Adductor muscle scars subcircular, distinct; cruciform muscle scars indistinct. Pallial line narrow, may be indistinct; pallial sinus deep, nearer to anterior adductor scar in left valve and confluent with pallial line. Margin smooth. Siphons long, narrow, separate.

Macoma phenax is abundant in the soft mud to sandy silt substrates of brackish creeks in the Chesapeake Bay where salinities are 2-20 °/oo; Castagna and Chanley (personal communication) extended the upper salinity limit to 30 °/oo, under laboratory conditions.

RANGE: Chesapeake Bay, Virginia, and Tampa Bay, Florida (Dall, 1900).

Macoma tenta Say, 1834 (Fig. 30)

Shell oval-elongate, posterior narrowed and slightly truncate, gaping; thin, fragile, moderately inflated; inequivalve, left valve more convex, both valves twisted toward right; inequilateral, beaks posterior to midline, directed posteriorly and ventrally; up to 20 mm (3/4 inch) in length; dull white, posterior end may be tinged with rust-orange or slight iridescence. Periostracum lacking. External ligament short, prominent band. Sculpture fine, concentric lines with few, fine radiating lines near midline; growth increments unclear. Interior of shell white tinged with yellow; sculpture fine radiating lines. Hinge plate narrow with two cardinal teeth in each valve; anterior cardinal bifid in left valve, posterior cardinal bifid in right; laterals lacking. Adductor muscle scars subequal, distinct; cruciform muscle scars may be distinct. Pallial line distinct, moderately wide; pallial sinus deep, nearer to anterior adductor scar in left valve and confluent with pallial line. Margin smooth. Siphons long, narrow, separate.

Macoma tenta is plentiful in muddy sand or sand at moderate depths. In Virginia it is found in silt-clay substrates at salinities ranging from 20-30 °/oo (Wass, 1965).

RANGE: Cape Cod to the West Indies.

Genus Abra Lamarck, 1818

Abra aequalis Say, 1822 (Fig. 31)

Shell subcircular; moderately thin, moderately inflated; equivalve; inequilateral, beaks posterior to midline directed toward each other; up to 12.5 mm (3/4 inch) in length; glossy white, may be slightly iridescent. Periostracum thin, clear, pale yellow. External ligament short, posterior to beaks, with internal element (resilifer) located in excavated area posterior and ventral to beaks. Sculpture smooth, fine concentric lines; growth increments clear. Interior of shell glossy white; sculpture lacking. Both valves with two thin cardinal teeth, posterior cardinal in left valve rudimentary; anterior margin of right valve grooved, indicating obsolete lateral. Adductor muscle scars clear, subcircular; cruciform muscle scars obscure. Pallial line narrow, may be indistinct. Pallial sinus deep, wide, confluent with pallial line, often indistinct. Margin smooth. Siphons separate, long, white, narrow.

The Atlantic Abra is a common species in 6-12 meters of water where salinities are above 25 $^{o}/oo$ (Menzel, 1964). It is only rarely encountered in Virginia.

RANGE: Virginia to the West Indies.

Abra lioica Dall, 1881

Distinguishing features from A. aequalis are: shell proportionately longer, more oblique, thinner; beaks nearer anterior end; up to 8 mm (⅓ inch) in length; groove on right anterior dorsal margin lacking. This common species is found in 12-400 meters of water (Perry, 1940).

Salinity tolerance and substrate preference are not known. In Virginia, it is extremely rare inshore.

RANGE: Cape Cod to the West Indies.

Genus Donax L., 1758

Donax variabilis Say, 1822 (Fig. 32)

Shell triangular, wedge-shaped, elongate anteriorly and slightly truncate posteriorly; thick, strong, moderately inflated; equivalve; inequilateral, umbones low, located at summit of posterior slope and directed posteriorly; up to 19 mm (3/4 inches) in length; color variable, white and green, shades of red, brown, lavender, purple and yellow, variously rayed. Periostracum inconspicuous or lacking. External ligament strong, deeply inset, short, posterior to beaks. Sculpture concentric growth lines with fine, radial striations, becoming stronger and elevated posteriorly; growth increments may be clear. Interior of shell variable, glossy white, yellow, pink, blue, lavender, often rayed with darker shades of color; sculpture faint, radial striations posteriorly. Left valve with two strong cardinal teeth separated by a fossa; two laterals, one located posteriorly and one anteriorly. Right valve with a large, triangular, bifid medial cardinal tooth flanked by two large fossae which receive cardinal teeth of left valve; two strong laterals, one posterior and one anterior, and two deep fossae located dorsally to laterals. Adductor muscle scars distinct, subcircular; cruciform muscle obscure. Pallial line distinct, moderately wide; pallial sinus extending to midline, moderately wide, distinct. Margin crenulate. Siphons moderately long, separate, white.

Donax inhabits the surf zone of sandy beaches where salinities are seldom below 30 °/oo; however, Castagna and Chanley (personal communication) established this species lower salinity limit in the laboratory as 12.5 °/oo. It is periodically abundant in Virginia on Virginia Beach and probably Eastern Shore.

RANGE: Virginia to Texas.

Donax fossor Say, 1822

Distinguishing features from D. variabilis are: up to 20 mm (3/4 inch) in length; almost smooth, yellow-white with purple rays.

Due to the extreme similarity between these two species and the periodicity of D. fossor, the latter has been suggested to be D. variabilis, the larvae of which washed northward and became established, or a cold-water subspecies of the typical species (Abbott, 1954; Jacobson and Emerson, 1961). D. fossor has been noted on Virginia's Eastern Shore on ocean beaches during summer and fall.

RANGE: Long Island, New York to Virginia.

Genus Tagelus Gray, 1847

Tagelus plebeius (Solander, 1786) (Fig. 33 a, b)

Shell subcylindrical, oblong, anterior truncate, gaping; moderately inflated, thick, strong; equivalve; slightly inequilateral, beaks just posterior to midline and indistinct; up to 100 mm (4 inches) in length; chalky white. Periostracum moderately thick, dull green-yellow, umbones often worn. External ligament strong, deeply attached, hinge highly expanded and bulbous at point of attachment. Sculpture faint,

irregular, concentric growth lines; growth increments unclear. Interior of shell white, chalky; external sculpture faintly visible internally. Both valves with two small, projecting cardinal teeth ventral to umbones; laterals lacking. Posterior adductor scar larger than anterior; both subcircular. Pallial line moderately thin. Pallial sinus deep, wide, extending to midline, confluent with pallial line. Margin smooth. Siphons white, separate, moderately long.

The stout razor clam is a euryhaline deposit feeder living in silty sand, on intertidal flats or in shallow water to at least 6 meters where salinities are above 10 °/oo. It is abundant in the Chesapeake Bay and its tributaries and on Eastern Shore.

RANGE: Cape Cod to South Florida and the Gulf States.

Tagelus divisus (Spengler, 1794) (Fig. 34)

Distinguishing features from T. plebeius are: shell thin, fragile; up to 38 mm (1½ inches) in length; often white-purple in color. Periostracum shiny, thin, with radial markings. Interior of shell with very weak radial rib lying dorsoventral just anterior to cardinal teeth, often obscure.

This clam is extremely similar to T. plebeius, inhabiting the same habitats and having the same range. In Virginia it has only been found in moderately high salinity water (25-35 °/oo). It is scarce in the mouth of the Chesapeake Bay, but abundant in Hog Island Bay.

Superfamily Solenacea

Shell elongate, gaping widely; equivalve; inequilateral, beaks inconspicuous at anterior end. Periostracum prominent. Ligament external, prominent, posterior to beaks. Cardinal and or lateral teeth present. Muscle scars and pallial sinus at irregular positions.

Quick Reference Chart to Species Characteristics

	S. costata	*E. directus*	*S. viridus*
Shell	ovate elongate	elongate rectangular, dorsal and ventral margin curving dorsally	elongate-rectangular dorsal and ventral margins straight
Interior	pale violet-white with raised rib	white, tinged with purple, rib lacking	white, rib lacking
Teeth	two cardinals and a posterior lateral in left valve, one cardinal and a bifid lateral in right valve	two cardinals and one lateral in left valve, one cardinal and one lateral in right valve	one cardinal in each valve, laterals lacking

Genus *Siliqua* Muhlfeld, 1811

Siliqua costata (Say, 1822) (Fig. 35)

Shell ovate-elongate; moderately gaping, thin, fragile, compressed; equivalve, inequilateral, beaks inconspicuous in anterior fourth of shell; up to 63 mm (2½ inches) in length; white. Periostracum smooth, glossy, yellow-green with two pale violet rays radiating from beaks to

ventral margin. Ligament strong, prominent, lying posterior to beaks. Sculpture fine concentric lines; growth increments clear. Interior of shell glossy, pale violet-white with large, prominent, raised, calcareous rib lying dorsoventrally beneath hinge to strengthen valves; sculpture lacking. Left valve with two cardinal teeth of which posterior is bifid and widely separated; posterior lateral small, tongue-shaped projection. Right valve with one cardinal tooth and one tongue-shaped, projecting, posterior lateral which is horizontally bifid. Adductor muscle scars prominent; posterior scar meets dorsal limb of pallial sinus over its whole width; anterior scar as long as ligament. Pallial line clear; pallial sinus deep. Margin smooth. Siphons united to their tips, which have scattered papillae.

This Atlantic razor clam is a vertical burrower in shallow water sand flats where salinities exceed 30 ^{o}/oo (Wass, personal communication). In Virginia it is found on Cedar Island, Wachapreague, Virginia.

RANGE: Gulf of St. Lawrence to North Carolina.

Genus Ensis Schumacher, 1817

Ensis directus Conrad, 1843 (Fig. 36)

Shell elongate-rectangular with ventral and dorsal margins curving dorsally, gaping, posterior rounded and anterior truncate; thin, brittle, compressed; equivalve; inequilateral, beaks inconspicuous at anterior end; up to 252 mm (10 inches, usually 3-5 inches in Virginia) in length; white. Periostracum thin, varnish-like, brown-green. Ligament dark brown. Sculpture smooth, fine rectangulate growth lines; growth increments clear. Interior of shell white tinged with purple; sculpture lacking. Left valve with two cardinal teeth and one lateral; right

valve with one cardinal tooth and one lateral. Anterior adductor scar extending beyond ligament and joined to small anterior dorsal scar. Posterior adductor scar at least as far as its length from dorsal limb of pallial sinus. Margin smooth. Siphons long, separate, white.

The common razor clam is rapid vertical burrower in sand flats where water salinities are 7.5 - 28 °/oo (Chanley, 1958). In Virginia it is abundant on the Eastern Shore; abundance is variable elsewhere at water depths of 15 - 150 meters and salinities above 20 °/oo (Wass, 1965).

RANGE: Labrador to Florida (Johnson, 1934).

Genus Solen L., 1758

Solen viridus Say, 1821 (Fig. 37)

Shell elongate-rectangular, dorsal and ventral margins straight, both ends truncate and gaping; thin, fragile, compressed; equivalve; inequilateral, beaks inconspicuous at anterior end; up to 53 mm (2 1/8 inches) in length; white or light and dark yellow. Periostracum thin, varnish-like, pale green, gray or brown. Ligament dark brown. Sculpture fine rectilinear growth lines, concentric with margins; growth increments clear. Interior of shell white; sculpture occasional, concentric impressions representing external growth increments. Both valves with one projecting cardinal tooth; laterals lacking. Both adductors distinct; anterior adductor scar reaching as far back as ligament, not joined to an anterior dorsal scar. Pallial line wide, distinct; pallial sinus distinct, posterior adductor scar meets upper

limb of pallial sinus over its entire length. Margin smooth. Siphons long, separate.

Solen is a moderately common burrower of shallow water sand flats in high salinity water. In Virginia, it is found only in sand bars of the barrier islands.

RANGE: Rhode Island to the Gulf States.

Superfamily Mactracea

Shell equivalve and slightly inequilateral. Ligament external and internal (in a triangular pit, chondrophore). Two or three cardinal teeth in each valve, laterals generally present; in left valve two cardinal teeth joined to form Λ-shaped projection. Adductor muscle scars about equal. Pallial line indented with a pallial sinus.

Quick Reference to Species Characteristics

	S. solidissima	M. lateralis	R. cuneata
Shell	oval, up to 180 mm	triangulate with posterior radial ridge, up to 14 mm	obliquely ovate, up to 60 mm
Ligament	external and internal	internal	internal
Laterals	serrated	lacking serrations	lacking serrations
Chondrophore	large, broad	small, triangular	small, deep, triangular
Left valve anterior-most cardinal teeth	Λ -shaped, long, thick	Λ -shaped, thin, short	blunt, very short

Genus Spisula Gray, 1837

Spisula solidissima (Dillwyn, 1817) (Fig. 38)

Shell oval; heavy, inflated; equivalve; inequilateral, beaks anterior to midline, directed toward each other and slightly anterior;

up to 180 mm (7 inches) in length; color dirty white. Periostracum shiny, thin, light brown. External ligament thin, short band posterior to beaks; internal ligament in large, deep, broad triangular chondrophore ventral and posterior to beaks. Sculpture of fine concentric lines; growth increments clear. Interior of shell white; sculpture lacking. Left valve with three cardinal teeth and two laterals, one posterior and one anterior; two anterior cardinals in left valve joined to form $\wedge$-shaped projection reaching third of way down hinge plate in adults; third cardinal fragile, often broken, lying posterior to these and anterior to chondrophore. Right valve with two separate cardinal teeth and four laterals, two anterior and two posterior. Top and sides of laterals in left valve serrate; inner surfaces of laterals in right valve serrate. Pallial sinus broad, rounded, extending posteriorly nearly to posterior border of posterior adductor, confluent with pallial line for short distance. Margin smooth. Siphons short and united.

The giant surf clam is intermittently abundant offshore, occurring from Chincoteague to Maine and supporting a large, commercial fishery in the mid-Atlantic states. Young occur inshore below the low water mark on exposed ocean beaches in surf-stirred, clean sand. Adults are often washed ashore by severe storms.

The subspecies S. s. similis Say is more elongate, the anterior is flatter, the pallial sinus longer and the small double tooth in the left valve is larger and stronger than in S. solidissima solidissima. Spisula solidissima similis is common and exists sympatrically with the typical S. solidissima from Cape Cod to South Carolina (Abbott, 1954).

RANGE: Nova Scotia to South Carolina; similis, Cape Cod to both sides of Florida and Texas (Abbott, 1954).

Genus Mulinia Gray, 1837

Mulinia lateralis (Say, 1822) (Fig. 39)

Shell triangulate with fairly distinct, single, low, radial ridge near posterior; firm, moderately obese; equivalve; nearly equilateral, beaks prominent just anterior to midline and directed toward each other; up to 14 mm (over ½ inch) in length; white to beige in color. Periostracum thin, yellow-brown. Ligament internal in small, triangular chondrophore pit. Sculpture of fine concentric lines; growth increments inconspicuous. Left valve with three small, thin cardinal teeth, two anterior-most joined in ⋀-shape, posterior-most tooth minute, easily broken; two lateral teeth, one anterior and one posterior. Right valve with two small cardinal teeth joined in ⋀ -shape; two anterior lateral teeth and two posterior lateral teeth. Laterals in both valves lacking serrations (a distinguishing character from young Spisula). Interior of shell white, smooth. Adductor scars about equal. Pallial line wide; pallial sinus wide, shallow. Margin smooth. Siphons united, short, white.

This dwarf mactrid clam is a very abundant species in silt, mud, clay or sand where the water is shallow and warm and the salinity is over 8 °/oo. In Virginia dense sporadic populations are found in silt areas and low reservoir populations in nearshore sand (Wass, 1965).

RANGE: Maine to Texas and the West Indies.

Genus Rangia Desmoulins, 1832

Rangia cuneata (Gray, 1831) (Fig. 40)

Shell obliquely ovate, posterior drawn out; moderately thick, inflated; equivalve; inequilateral, umbo high, inrolled, just anterior to midline, beaks directed anteriorly and ventrally; up to 60 mm (2½ inches) in length; color brown. Periostracum strong, smooth, gray-brown. Ligament internal, in small, deep triangulate chondrophore. Sculpture of concentric ridges with fine radiating ribs; posterior portion sharply curved inward, forming rather abrupt radial ridge. Growth increments clear. Interior of shell white, margins glossy; sculpture lacking. Left valve with one lateral and three cardinal teeth anterior to chondrophore and one lateral posterior to chondrophore; two anterior cardinals joined to form blunt tooth, posterior cardinal reduced; anterior lateral large, recurved and club-shaped, marginal edge serrate; posterior lateral long, thin. Right valve with two small cardinals; posterior lateral large, triangulate, marginal surface serrate; two anterior laterals, marginal lateral reduced to small ridge, marginal edge of visceral lateral serrate. Adductor scars slightly impressed. Pallial line narrow; sinus small but distinct, formed by S-shaped indentation of pallial line. Margin smooth. Siphons united and short.

The marsh clam is a common fresh to brackish water species in coastal areas. It is abundant in mud or sandy mud in the James, the Rappahannock and the Potomac rivers, and Back Bay (Brehmer, personal communication), where the salinity of the water is below 20 °/oo (usually 5-10 °/oo).

RANGE: Potomac River, Maryland (Pfitzenmeyer and Drobeck, 1964) to Texas.

Superfamily Myacea

Shell light; inequivalve; inequilateral, gaping. Periostracum thin. Ligament mainly internal, connected to projecting chondrophore in left valve and concealed chondrophore in right. Hinge plate and true teeth absent. Muscle scars unequal in shape. Pallial sinus deep.

Genus Mya L., 1758

Mya arenaria (L., 1758) (Fig. 41)

Shell elongate to roundly ovate in outline, rounded anteriorly, posterior half narrower and gaping widely; light, moderately inflated; inequivalve, right valve more convex than left; inequilateral, umbones subcentral to central, beaks in front of midline, directed inward and touching; up to 152 mm (6 inches) in length; color dirty white or fawn. Periostracum light gray, straw-yellow or fawn. Ligament mainly internal (external concealed). External sculpture of concentric ridges; growth increments unclear. Interior of shell dull white, flesh or straw-yellow; external sculpture faintly visible internally. Chondrophore-complex in left valve consisting of large shallow chondrophore anterior to beak, with anterior edge projecting from hinge at an angle of 90-100°; bordered posteriorly by: (1) a triangular pit with a gradual anterior slope, (2) a conspicuous, long, recurved rectangular ridge with a scooped out central portion, and (3) a flat, fan-shaped platform with a pitted appearance (Foster, 1946). Right valve with large,

shallow, unevenly elevated chondrophore anterior to beak and concealed beneath umbo. Anterior adductor scar elongate, about twice as long as posterior and nearly bisected by midline; posterior scar suboval in upper third of shell. Pallial line wide; pallial sinus rectangular, about twice as long as wide, and extending just anterior to umbo. Margin smooth. Outline, texture and thickness of shell variable. Siphons long, united in tough dark tubular sheath.

The soft clam is circumboreal species, able to survive water salinities down to 2.5 °/oo (Chanley, 1958), often living in areas of considerable salinity fluctuation. It burrows into mud, sand and sandy gravel in habitats from intertidal to 10 meters or more. Mya is an important commercial species, common to abundant in Virginia in the above habitats, and known by such local names as gapers, long neck clams, mannoses, butterfish and steamers.

Superfamily Pholadacea

Shell mostly irregular in outline, equivalve; inequilateral, frequently gaping; accessory plates variously developed about main shell in Pholadidae or far removed from shell, such as pallets in Teredinidae. Internal ligament reduced or lacking. Hinge line lacking true teeth, with articulating surfaces such as condyles and umbonal reflections on which valves rock rather than open. Foot muscles attached to apophysis.

Quick Reference to Species Characteristics*

	Barnea	Cyrtopleura	Diplothyra	Bankia	Teredo
Siphons united	X	X	X		
Siphons separated				X	X
Apophysis	X	X	X	X	X
Protoplax	X	X			
Mesoplax		X	X		
Metaplax			X		
Condyles				X	X
Hypoplax			X		
Callum			X		
Pallets segmented				X	
Pallets united					X

*Modified after Turner (1954); apophysis through callum, "X" refers to presence of.

Genus Barnea Risso, 1826

Barnea truncata (Say, 1822) (Fig. 42)

Shell rectangulate, posterior truncate, anterior pointed, with a wide pedal gape; thin, very fragile, brittle, slightly inflated; equivalve; inequilateral, umbones in anterior third of shell covered by closely appressed umbonal reflection, beaks directed anteriorly; up to 70 mm (2 3/4 inches) in length; white. Periostracum thin, light straw-yellow. Ligament small, attached to projecting chondrophore. Sculpture concentric ridges and radiating ribs drawn into small spines where they cross, spines prominent anteriorly. Growth increments unclear. Apophysis thin, long, flat. Protoplax calcareous, broadly lanceolate, curved ventrally, posteriorly fitting over umbo. Interior of shell white, glossy; external sculpture faintly visible internally. Anterior adductor scar long, thin, lying on umbonal reflection; posterior adductor scar about halfway along dorsal line. Pallial line wide, expanded with anterior adductor scar; pallial sinus nearly as wide as shell is high, extending halfway to umbo. Margin smooth except anterior border having small projecting spines. Siphons united, enclosed in tough tubular sheath, may extend 10-12 times length of shell (Turner, 1954).

Specimens are found in peat, mud, clay, soft rock and wood, from low intertidal to considerable depths. In Virginia, Barnea is abundant in peat where salinities are between 16-35 $^{o}/oo$.

RANGE: Maine to Brazil; Dakar, Senegal south to Accra, Gold Coast. (Turner, 1954).

Genus Cyrtopleura Tryon, 1862

Cyrtopleura costata (L., 1758) (Fig. 43)

Shell oval, rounded at both ends with long, narrow pedal gape; light, fragile, inflated; equivalve; inequilateral, umbones prominent, located near anterior fourth of shell, partially covered by umbonal reflections; up to 183 mm (about 7¼ inches) in length; chalky white in color, occasionally tinged with pink. Periostracum thin, light gray to straw-yellow. Ligament attached to small chondrophore. Sculpture relatively weak concentric ridges and about 30 strong, beaded, radial ribs over entire shell, imbrications formed where these cross; growth increments clear. Apophysis short, wide, triangular, broadly spoon-shaped, hollow at end. Protoplax chitinous, flat, large, thin, triangulate, pointed in anterior, broadened posteriorly. Mesoplax transverse, calcareous, heavy, sub-triangulate, lying anterior to protoplax. Interior of shell white, glazed, occasionally tinged with pink; sculpture ribbed and pitted. Anterior adductor scar long, lying on umbonal reflection; posterior adductor scar moderately long, lying 2/3 of way along dorsal line, ledge of shell often near adductor for added muscle attachment; both scars well-defined. Pallial line clear; pallial sinus shallow, wide, often not apparent. Margin broadly scalloped in anterior, slightly crenulated in posterior. Siphons united, smooth, long, extending to 24 inches or more, color gray-white with red-purple lateral stripes at distal end.

The angel wing is widely distributed throughout the western Atlantic and is very abundant locally. It lives in permanent burrows

at depths greater than one meter (Turner, 1954) in sand to soft, sticky mud, at and below the low water mark. Cyrtopleura is common in Virginia in silt-clay and mud nearshore where the salinity exceeds 10 °/oo (Wass, 1965).

RANGE: Fall River, Massachusetts to Rio de Janeiro, Brazil (Turner, 1954).

Genus Diplothyra Tryon, 1862

Diplothyra smithii Tryon, 1862 (Fig. 44)

Shell pear-shaped in outline, with wide pedal gape closed by strong callum in adult; light, brittle, inflated; equivalve; inequilateral, umbones prominent, near anterior fourth of shell, umbonal reflection thin and closely appressed to umbones; up to 15.5 mm (about ½ inch) in length; white to light brown in color. Periostracum light gray-brown to straw-yellow, fine. Internal ligament attached to chondrophore, well-developed. Sculpture: (1) anterior triangular in outline with exceedingly fine, close-set, undulating, concentric ridges and numerous radial ribs; (2) umbonal-ventral sulcus dividing shell into anterior and posterior; (3) posterior with rather strong growth lines; (4) pronounced ridge extending longitudinally over umbones; (5) mesoplax subquadrate to subtriangulate, extending anteriorly to cover anterior adductor muscle; (6) metaplax and hypoplax pointed anteriorly, posteriorly extending over posterior margins of valves and fusing with one another. Protoplax lacking. Callum extending dorsally between beaks, over umbonal reflection and posteriorly for nearly half length of mesoplax on either side.

Interior of shell white, usually glazed; internal sculpture lacking except for slightly beaded ridge indicating external sulcus. Hinge with pronounced chondrophore on left valve. Posterior adductor muscle scar ovate, large, lying about halfway along dorsal line; anterior adductor scar moderately large, elongate, lying on umbonal reflection. Pallial line well-defined; pallial sinus broad, deep, extending anteriorly beyond sulcus. Margin smooth, except slightly scalloped anteriorly. Siphons smooth, short, united, white, extending only slightly beyond end of shell.

Diplothyra is a common borer of shells, coquina rock and rarely of wood (Turner, 1955), in salinities above 25 °/oo (Menzel, 1964). It is rare in Virginia.

RANGE: Provincetown, Massachusetts to Florida and Texas.

Note: Martesia cuneiformis Say, 1822 has been found rarely in Virginia in driftwood. In all probability these do not represent an endemic population since the range for this species has been given as Carteret County, North Carolina to the West Indies (Turner, 1966).

Genus Bankia Gray, 1842

Bankia gouldi Bartsch, 1908 (Fig. 45)

Shell hemispherical, with deep right-angled anterior notch; light, fragile, strongly convex, gaping widely; equivalve; inequilateral, beaked just anterior to midline, umbones and beaks directed toward each other; shell up to 8.5 mm (¼ inch) in length (Clench and Turner, 1946); white. Periostracum yellow to golden brown, fine.

Ligament internal, small, attached to small chondrophore (Turner, 1966). Sculpture: (1) anterior lobe with numerous very fine, concentric, serrated ridges; (2) anterior disc with equal number of serrated ridges; serrations coarser and ridges finer than lobe; (3) median disc with dorso-ventral elevated area, exceedingly fine growth lines not serrated; (4) posterior disc nearly smooth, growth lines running obliquely; (5) auricle smooth, slightly depressed dorso-ventrally through center, posterior margin flaring outwardly (Clench and Turner, 1946). Growth increments lacking. Interior of shell white; external sculpture visible internally. Apophysis scimitar-shaped, long, flattened antero-posteriorly. Hinge greatly reduced, with dorsal and ventral condyle. Posterior adductor muscle scar large, strong, lying on auricle; anterior adductor muscle scar small, weak, lying on umbonal reflection anterior to umbones. Margin smooth, but irregular in outline. Siphons fairly long, separate, white. Pallets elongate, plume-like, segmented, series of closely spaced cones; calcareous portion funnel-shaped, inner margin wider than outer.

Gould's shipworm is an abundant destructive wood-borer at salinities above 10 $^{o}/oo$. In Virginia it is abundant in Chesapeake Bay, but is scarce or absent in high salinity oceanic water (Castagna and Chanley, personal communication).

RANGE: New Jersey, West Indies, Central America, probably as far as Brazil; eastern Pacific at Panama (Clench and Turner, 1946).

Genus Teredo L., 1758

Teredo navalis L., 1758 (Fig. 46)

Shell helmet-shaped, outline irregular, posterior and anterior margins notched and gaping, semi-circular auricle projecting posteriorly; brittle, thin; equivalve; inequilateral, umbones bulbous in anterior half; rarely more than 9.5 mm (3/8 inch) in length; white in color. Periostracum light brown to pale straw-yellow. Ligament inconspicuous or lacking. Sculpture: (1) anterior lobe 50-100 fine serrated ridges, parallel with upper margin of ventral gape; (2) anterior disc with serrated ridges oriented obliquely from posterior border of anterior lobe; (3) median disc narrow groove with fine concentric lines, some deeply incised; (4) posterior disc smooth with fine concentric lines; (5) auricle with fine concentric lines, external border a clear suture (Tebble, 1966). Hinge line with slightly incised shoulder anteriorly. Interior of shell white; sculpture low, median groove, internal anterior border of auricle firm ridge; dorsal and ventral condyles. Apophysis club-shaped, moderately long, strong. Posterior adductor sub-elliptical, large, lying on auricle; anterior adductor scar elongate, small, lying anterior to umbones. Margin smooth. Siphons long, separate, white in color. Pallet paddle-shaped, symmetrical, one piece, calcareous, dirty white in color; blade one piece, convex outwardly, flat inwardly, distal end with forked tip bordering cup-like terminal depression; stalk calcareous, short; prominent suture where stalk and blade meet. Form, shape, size and sculpture may be dependent on substrate (Turner, 1966).

This cosmopolitan shipworm is a destructive euryhaline species boring in wood where salinities range from 6-40 °/oo. In Virginia this species is abundant on the seaside of Eastern Shore. According to Turner (personal communication), the distribution of *T. navalis* is limited by temperature and it may die out in summer.

RANGE: Both coasts of United States; Europe; Africa (Tebble, 1966).

Superfamily Pandoracea

Shell slightly inequivalve and inequilateral. Hinge plate and true teeth lacking, tooth-like structures may develop near dorsal line. Ligament internal, external or both; internal ligament may be strengthened by calcareous plate or lithodesma, which may be lost. Pallial line normally with a sinus, but may be represented by series of small muscle scars with no sinus. Adductor muscle scars about equal.

Genus Lyonsia Turton, 1822

Lyonsia hyalina Conrad, 1831 (Fig. 47)

Shell elongate, approximately oval in outline, posterior dorsal line straight, posterior margin abruptly truncate and gaping; fragile, thin, moderately compressed; almost equivalve, left valve slightly more convex than right; inequilateral, beaks anterior to midline, directed anteriorly; up to 27 mm (about 1 inch) in length; translucent, glossy, white to beige in color. Periostracum light brown, often with agglutinated sand grains. Internal ligament ventral and posterior to beaks, lying in elongated, narrow, longitudinal ridge, with underlying, supporting, white, calcareous lithodesma broadened posteriorly. Sculpture radiating lines with concentric undulating ridges; growth increments unclear. Interior of shell glossy white; external sculpture visible internally. Adductor muscle scars faint.

Pallial line wide, irregular; pallial sinus slight, often inconspicuous. Margin smooth. Siphons short, white, separate.

Lyonsia is common from low water to 68 meters in fine sand to sandy silt. It is abundant in the lower Chesapeake Bay and its tributaries where salinities are above 15 °/oo; under laboratory conditions the salinity survival range is 7.5 to at least 30 °/oo (Chanley and Castagna, personal communication).

RANGE: Nova Scotia to Florida (Menzel, 1964).

Genus Pandora Chemnitz, 1795

Pandora trilineata Say, 1822 (Fig. 48)

Shell crescent-shaped with strong, square ridge along hinge margin extending posteriorly into moderately long rostrum; thin very compressed, nearly flat; inequivalve, left valve overlapping right ventrally; inequilateral, umbo at anterior fourth or fifth of valve; up to 30 mm (1¼ inches) in length; color white, sometimes glossy and transparent. Periostracum inconspicuous or absent. Ligament internal resilium. Sculpture irregular, weak, concentric lines. Interior of shell dull white; external sculpture faintly visible internally. Left valve from anterior to posterior: (1) anterior cardinal tooth, strong, extending parallel to dorsoventral axis; (2) deep central fossa (cavity); (3) median cardinal tooth raised, thin, separating fossa from resilial complex; (4) lithodesma calcareous, supporting resilium; (5) resilium resting on excavated surface; (6) posterior fossa; (7) posterior cardinal tooth obsolete. Right valve with straight anterior ridge-like cardinal tooth; median

cardinal tooth pedunculate, thickened; posterior cardinal tooth long, thin with resilium resting on under surface. Adductor muscle scars large, circular and impressed. Pallial line discontinuous, irregular, individual scars between adductor scars, often unclear. Margin smooth. Siphons lacking.

This delicate species is moderately common in mud, sand and sand-gravel substrates below low water to 48 meters (Boss and Merrill, 1965). It is rare in Virginia in the Chesapeake Bay from off the Rappahannock River to the mouth in moderate to high salinities (Wass, 1965).

RANGE: Chesapeake Bay, Virginia to Texas.

Superfamily Poromyacea

Shells fragile; mostly equivalve, but one valve may be slightly larger; mostly equilateral, but may be inequilateral if posterior is extended into spout. Ligament external and/or internal, lithodesma may be present. Hinge with cardinal and/or lateral teeth. Pallial sinus sometimes present.

Genus Cardiomya A. Adams, 1864

Cardiomya gemma Verrill and Bush, 1898 (Fig. 49)

Shell subovate with well-defined posterior, projecting spout turned distally and gaping terminally, ventral margin broadly rounded; thin, fragile, moderately compressed; inequivalve, left valve just slightly more convex than right and overlapping it; slightly inequilateral, beaks inconspicuous, just posterior to midline; up to 5 mm (¼ inch) in length; white. Periostracum inconspicuous or lacking. Ligament internal in small grooved chondrophore, with a supporting and enclosing lithodesma. Sculpture very delicate lines of growth with three prominent, thin, elevated radial ribs on posterior half, and a fourth, less distant rib, near midline, ribs not reaching umbones; growth increments indistinct. Interior of shell white, translucent; external sculpture visible internally. Hinge plate narrow, cardinal teeth lacking; right valve with small, prominent, moderately long lateral tooth, separated from chondrophore by a notch. Muscle scars and pallial line indistinct.

Pallial sinus lacking. Margin crenulate where met by ribs. Siphons lacking.

Cardiomya is relatively rare, living in fairly deep water in Chesapeake Bay, probably where salinities are moderate to high (Wass, 1965).

RANGE: lower Chesapeake Bay (Wass, 1965) and Cape Hatteras, North Carolina at 32-34 meters (Johnson, 1934).

Superfamily Solemyacea

Shells fragile, gaping at both ends. Periostracum polished, extending well beyond margin of valves. Hinge lacking teeth. Pallial sinus lacking.

Genus *Solemya* Lamarck, 1818

Solemya velum Say, 1822 (Fig. 50)

Shell elongate-ovate, gaping; fragile, paper-thin, only slightly calcified, moderately inflated; equivalve; inequilateral, beaks in anterior third and inconspicuous; up to 25 mm (1 inch) in length; color polished brown due to periostracum. Periostracum smooth, shiny, horny, brown; radially marked and extending beyond margin as fringe. External ligament relatively strong, deeply inset. Sculpture inconspicuous; growth increments unclear. Interior of shell light blue-violet; lighter lavender lines representing external breaks in periostracum extend from umbo to margin. Hinge with posterior prop supporting internal ligament bifurcating just dorsal to anterior adductor. Posterior adductor scar subcircular lying about 3/4 of distance along dorsal line; anterior adductor scar circular, lying ventral to prop. Pallial line narrow, irregular, often inconspicuous. Margin smooth. Siphons lacking.

The common Atlantic awning clam is associated with *Zostera* on intertidal mud flats and subtidal mud where water salinities are

above 15 °/oo. This species is capable of swimming by opening and closing its valves. In Virginia Solemya is scarce to common on Zostera beds and sand.

RANGE: Nova Scotia to Florida (Menzel, 1964).

GLOSSARY

Adapted from: Arnold (1965); Keene (1958, 1963); Hunter and Brown (1964); Tebble (1966); Turner (1954).

Adductor muscle scar (L. ad = to; duco = lead): generally striated depression on shell interior; representing site of attachment of adductor muscles, contractions of which close valves (1-3 in number)

Anal muscle scar: small triangulate impression in internal shell of Mytilacea, lying between posterior adductor muscle scar and pallial line and representing site of attachment of anal muscles, which are a modification of the mantle

Anterior (L. ante = before): situated distal to posterior end, siphons, pallial sinus and external ligament; beaks generally directed toward, and may lie in anterior (e.g. Solenacea and Mytilacea)

Apophysis (sing.), -es (plural) (Gr. apo = from; phyo = to grow): a peg-like, finger-like or spoon-shaped, calcareous projection in each valve, ventral to umbones, projecting from hinge to which foot muscles are attached

Auricle (L. auris = ear): ear-shaped, projecting posterior portion of a teredinid valve

Beak (L. beccus = a beak): extreme tip of each valve, lying near hinge and representing oldest part of the shell

Bifid (L. bi = two; findere = to cleave, divide): divided by a groove into two parts or halves, especially applied to cardinal teeth

Bifurcate (L. bi = two; furca = fork): divided into two stems, branches, or arms; forked

Byssal aperture: small opening on the ventral margin, or right valve in Anomiacea, for the passage of the byssus

Byssus (Gr. byssos = a fine flax): a bundle of tough organic threads or fibers secreted from gland in foot and usually issued anteriorly between valves for permanent or temporary attachment to substrate

Callum: sheet of chitinous or partly calcified material laid down by the adult to partially or completely close pedal or anterior gape between valves

Callus (L. callus = hardened skin): local area of smooth, calcified thickening secreted by surface of mantle

Cardinal (L. cardinalis = pertaining to a hinge, important): pertaining to central, principal or main; cardinal area--a flat or curved region between beak and hinge line; cardinal teeth--projections, generally located medially or below beaks, diverging from the hinge; main hinge teeth

Chondrophore (Gr. chondros = cartilage; phero = bearing): large calcified pit or spoon-shaped structure near hinge line, representing modification of hinge line to support internal ligament (resilifer)

Compressed (L. cum = together; premo = pressed): flattened laterally or pressed together; flattened or shallow shells

Concentric (L. con = with; centrum center): lines or ridges congruent to, or roughly paralleling, umbo or ventral margin

Condyle (Gr. kondylos = knuckle): enlarged, prominent, rounded shoulder or knob on which valves move or rock in some species of Pholadacea

Crenulated (L. crena = a notch): regular, finely notched or corrugated edge of an internal shell margin

Cruciform muscle scars: two small scars ventral to pallial sinus, representing attachment sites of muscles which withdraw siphons in the Tellinacea

Denticulate (L. denticulatus = furnished with small teeth): having fine raised points like little teeth; denticles--minute tooth-like projections in each valve, especially on hinge; dentition--arrangement and character of teeth and sockets in the hinge

Dimyarian (L. di = two; mys = muscle): a name for bivalves with two approximately equal adductor muscle scars in each valve.

Disc (Gr. diskos = disk): space between umbo and margin of shell lying between sulcus and posterior slope in the Pholadacea

Distal (L. di = apart; sto = stand): relatively remote from center of body or point of attachment

Dorsal (L. dorsum = the back): back edge of a bivalve, usually in region of hinge or distal from pallial line

Dorsoventral (L. dorsum = back; venter = belly): in the direction or axis from dorsal to ventral surfaces

Ear: lateral triangulate projection or prolongation resembling an ear on dorsal shell margin (e.g. Pectenacea)

Edentate (L. edentatus = without teeth): lacking teeth in the hinge

Equilateral (L. aequus = equal; latus = side): posterior and anterior halves of a valve equal in size and shape due to symmetrical, or nearly so, growth on either side of beaks

Equivalve (L. aequus = equal; valva = leaf of a door): with both shell valves similar or equal in size and shape

Escutcheon (L. scutum = a shield): an elongated or heart-shaped depression, or smooth area on external valves posterior to ligament in some species

Fossa (L. fossa = a ditch, a trench): a shallow depression or cavity

Fringe (L. fimbriac = a fringe, border): edging; type of periostracum extending over edge of mantle

Gape (Ice. gapa = to yawn, gape): an opening or space left along margin or between valves of some species when adductor muscles contract fully (e.g. Mya, Solen, Ensis)

Growth increment: approximately concentric lines extending from beaks toward ventral margin and indicating cessations of growth, often annually, and superimposed on the species sculptural pattern

Heteromyarian (Gr. heteros = different; mya = muscle): having markedly unequal adductor muscles (e.g. Mytilacea)

Hinge (ME. hengen = hang): dorsal region of shell where valves meet, usually held together by interlocking teeth; hinge plate--infolded dorsal margin carrying hinge teeth; hinge teeth--interlocking teeth uniting valves

Hypoplax (Gr. hypo = under; plax = flat and broad): an accessory, long, narrow, usually calcareous, ventral plate extending from umbonal-ventral sulcus posteriorly to cover ventral margin gape between valves

Inequilateral (L. in = not; aequus = equal; latus = side): valves laterally dissimilar in shape and size since umbones are nearer one end than the other

Inequivalve (L. in = not; aequus = equal; valva = leaf of a door)· valves dissimilar, with one larger, more convex, or of different form

Inflated (L. inflatus = blown up): applied to rotund shells of thin structure, swollen, increased unduly or distended

Lateral (L. latus = side): pertaining to the side; lateral teeth--interlocking teeth lying on either side of cardinal teeth, not functioning as a hinge but serving to prevent valves from sliding upon each other when closed

Left Valve: left valve is approximately positioned when shell is held with external hinge up, apex or umbo pointed away, and pallial sinus or siphons toward observer (note: in Mytilacea and Solenacea the ligament is a reliable character, the beaks are in the anterior end; in Arcacea the ligament and beaks should be up; in the remaining species with an internal ligament the beaks are reliable)

Length: greatest horizontal dimension at right angles to height

Ligament (L. ligula = tongue): a tough elastic band of fibers which may be either external and lying posterior to beaks (tensilium), or internal and lying in a pit (resilium), or both, and which reacts against pull of adductor muscles to open valves by pulling them apart

Lithodesma (Gr. lithes = stone; desma = bond): calcareous reinforcement supporting internal ligament in a few species

Lunule (L. lunula = crescent shaped): heart-shaped impression set off by difference in sculpture, anterior to umbones on edge of both valves

Mesoplax (Gr. mesos = middle; plax = tablet): calcareous transverse plate in one or two pieces, originating ventral to anterior adductor muscle scar and protecting posterior margin of scar in Pholadacea

Metaplax (L. meta = behind; plax = tablet): a long, narrow, usually calcareous plate attached to dorsal valve margins by chitinous fold and covering dorsal margin gape posterior to umbones in Pholadacea

Midline: imaginary line dividing valves dorsoventrally midway between anterior and posterior margins

Monomyarian (Gr. mono = one; mys = muscle): having a single adductor muscle scar in each valve, usually located posterior to midline

Obsolete (L. obsoletus = to go out of use): obscure; not very distinct; atrophied, rudimentary, imperfectly developed

Ovate (L. ovatus = an egg): egg-shaped, oval; having a shape somewhat resembling longitudinal section of a hen's egg

Pallets (L. palo = spade): paired, simple or compound, calcareous structures at distal (siphonal) end for closure of burrow when siphons are withdrawn in the Teredinidae

Pallial Line (L. pallum = a cloak): fine, linear impression, normally concentric with ventral margin, connecting posterior and anterior adductor muscle scars, and marking attachment of mantle margin to shell; may be indented by a sinus or exceptionally may be composed of a series of separate muscle scars in Pandoracea

Pallial Sinus: notch, indentation or curved embayment of pallial line, often pronounced, having its opening in posterior half of shell and sometimes confluent with pallial line for a distance

Papillose (L. papilla; a nipple, pimple): covered with minute nodes, bumps or pimples

Periostracum (Gr. peri = around; ostrakon = shell): proteinaceous outer layer covering the shell of many species as a protection against erosion, in various textures and thicknesses (e.g. varnish-like, hairy, thin, transparent)

Posterior (L. post = after, behind): situated distal to anterior part of the shell, pallial sinus, ligament, and siphons usually located in this region

Prodissoconch (L. pro = before; dis = two; concha = shell): first formed, embryonic, rudimentary shell often visible about beaks of adults as small smooth area

Protoplax (Gr. proto = before): single, calcareous or chitinous accessory plate, lying anterior to umbones and dorsal to anterior muscle scar in the Pholadacea

Quadrate (L. quadratus = square): four-sided or rectangular in outline

Radial (L. radius = a ray): extending from a center; radiating-- ribs, lines, or bands of color spreading out toward ventral margin from umbones; rays-- relatively unbroken, fine lines radiating from umbones; ribbed-- raised, relatively unbroken sculptural pattern, extending from umbones to ventral, anterior or posterior margins

Rectilinear (L. rectus = straight; linea = line): straight, formed in straight lines, bounded by straight lines

Recurved (L. re = back; curvus = bent): turned backward, curved or bent backward or downward

Reflected (L. re = again; flectere = to bend or turn): thrown back, turned from the general course of the structure, curved, or folded backward

Resilium (L. resilio = leap or spring back, rebound): generally triangular, internal ligament residing in a chondrophore or pit along inner hinge margin and causing shell to spring open when muscles relax

Retractor Muscle Scars: small impressions located anteriorly and posteriorly in the internal shell of certain species, representing attachment sites of retractor muscles of the foot and the byssus

Right Valve: See left valve

Septum (L. septum = a partition): calcareous plate or partition

Serrate (L. serratus = to saw): toothed; sharp notches along the edge like a saw

Siphon (Gr. siphon = siphon): tube-like structures formed by an extension or fold of the mantle for conveyance of water

Spatulate (Gr. spathe = broadsword): oblong with an attenuated base, shaped like a spatula, a linear form enlarging suddenly into a rounded extremity

Sub- (L. sub = under, below): prefix indicating somewhat, almost, nearly, not quite, slightly (subglobular, subequal)

Sulcus (L. sulcus = furrow): groove, slit, furrow, fissure

Taxodont (Gr. taxis = order, arrangement; dont = tooth): hinge dentition composed of numerous, similar, interlocking teeth and alternating sockets

Teeth (AS toth = tooth): projections from hinge which engage corresponding sockets in opposite valve, usually in dorsal margin

Truncate (L. truncus = maimed): cut off, terminating abruptly, appearing as if cut off or broken squarely

Umbo (sing.); -ones (plu.); (L. umbo = a knob or boss): surface or valves immediately behind beaks and usually above hinge, normally convex

Umbonal Reflection: reflection of dorsal margin of valves anterior to and usually over umbones in the Pholadacea; anterior adductor muscle usually attached to reflection

Ventral (L. ventar = belly): edge generally distal to hinge and umbones; mantle and foot generally located ventrally

Vestigial (L. vestigium = a footprint): small, atrophied, or degenerated from ancestral development, structure previously more complete in functional activity

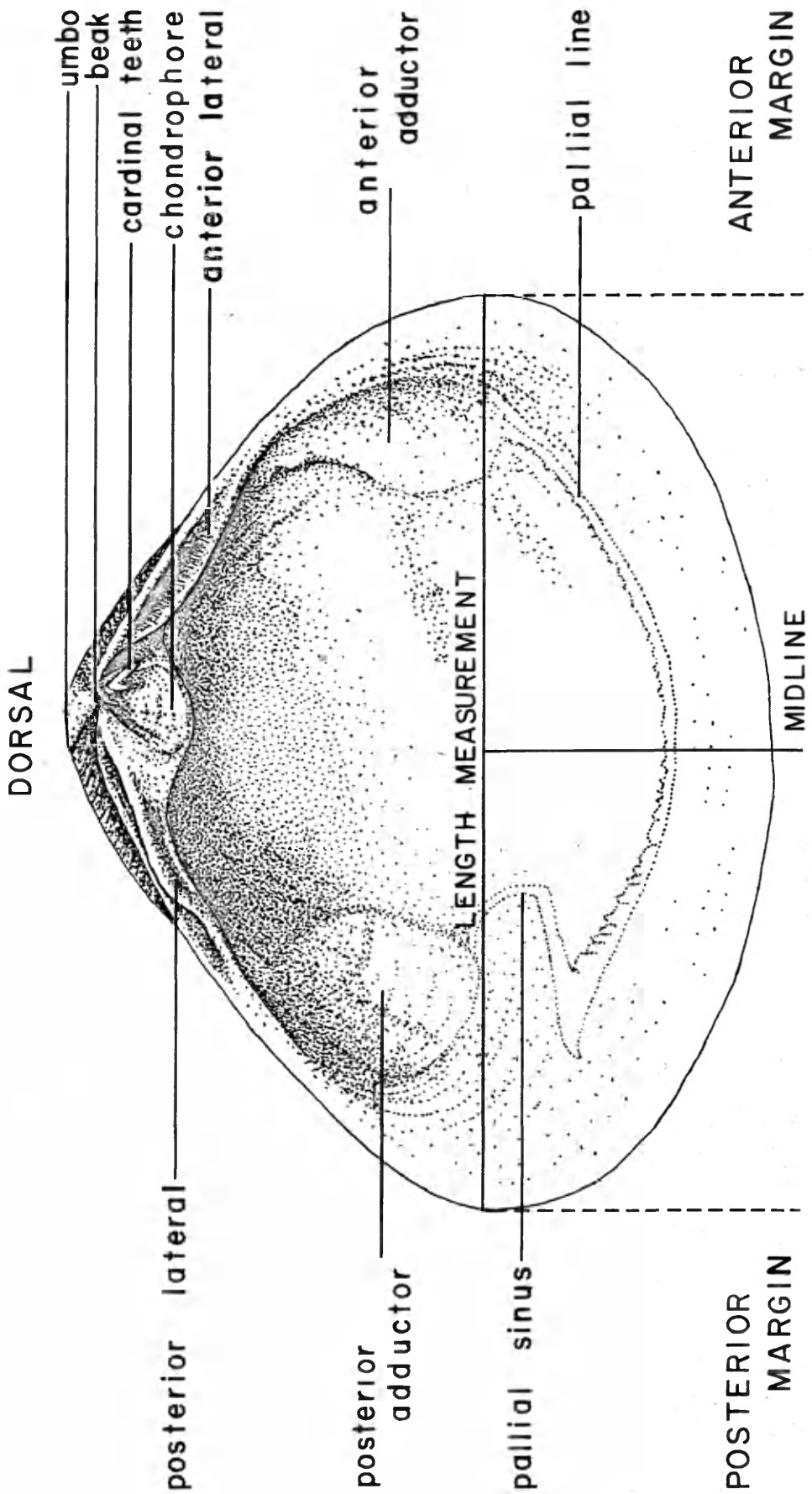


FIG. I LEFT VALVE WITH FEATURES LABELED

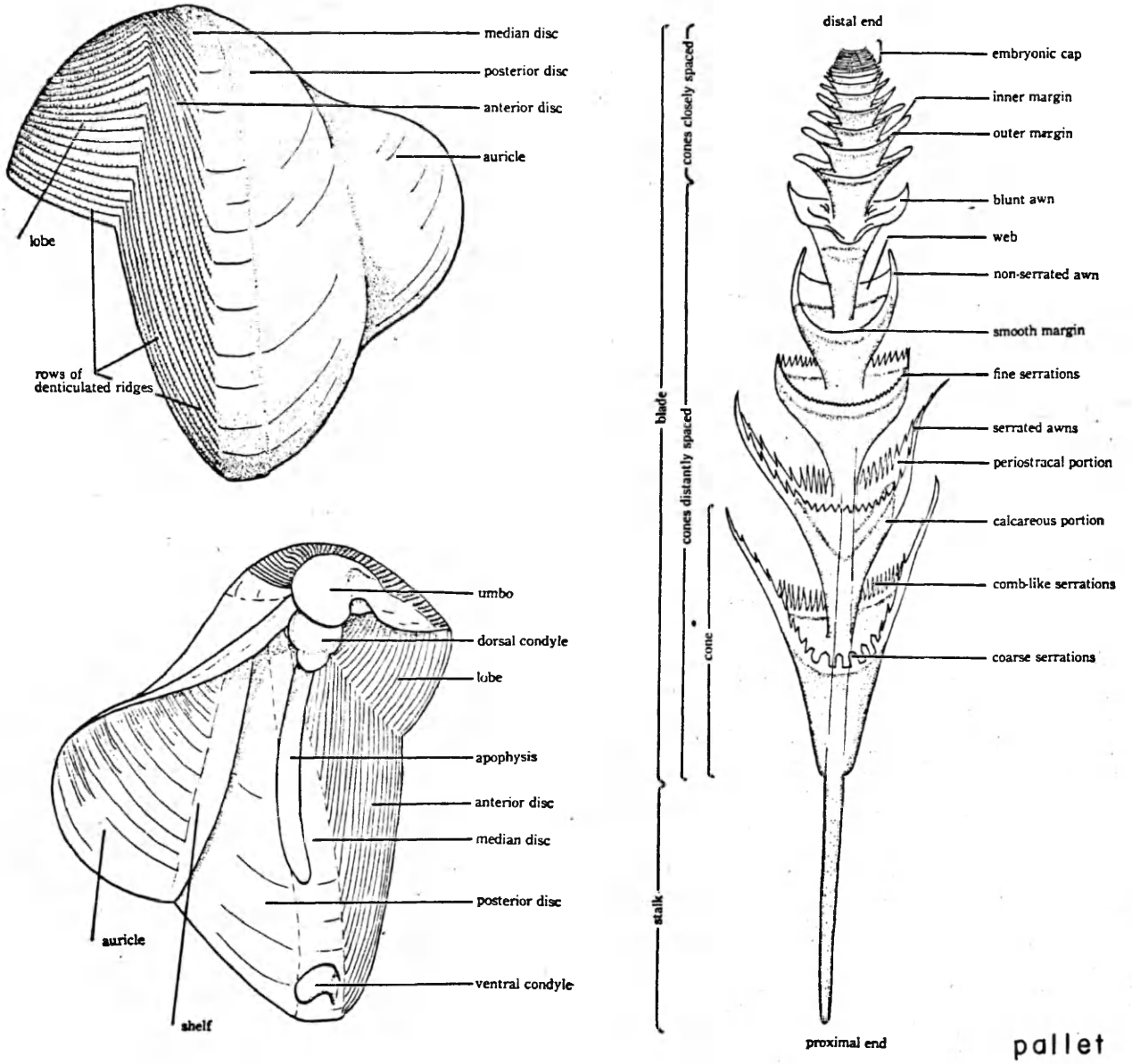


FIG. 2 LEFT VALVE OF A TEREDINID (FROM CLENCH, 1946)

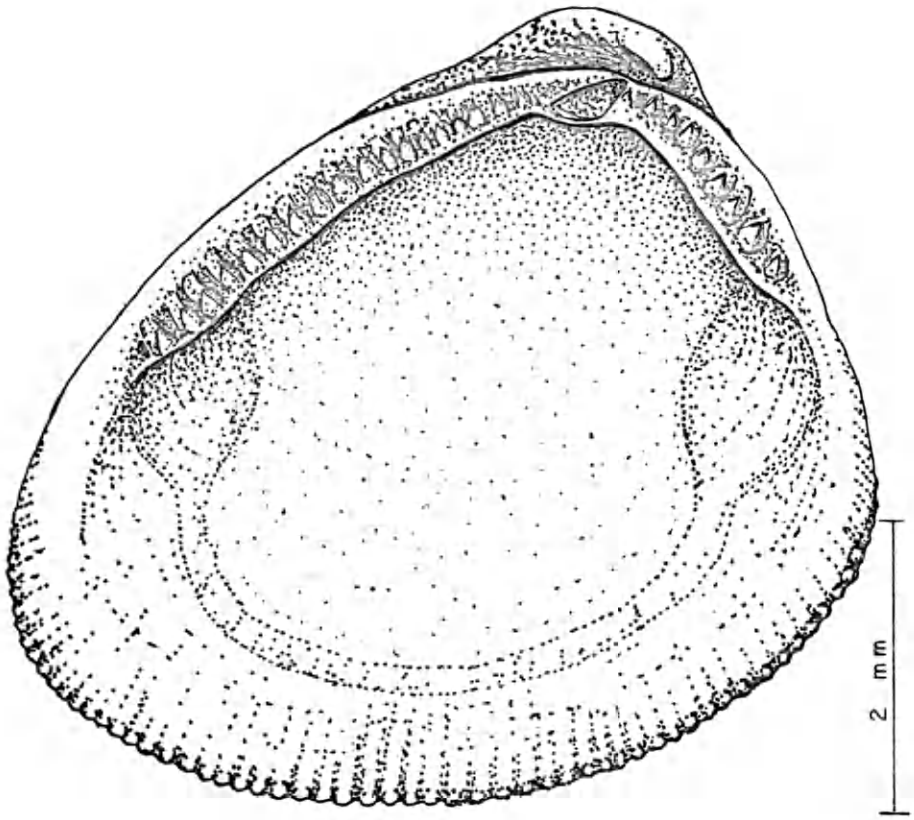


FIG. 3 *Nucula proxima*

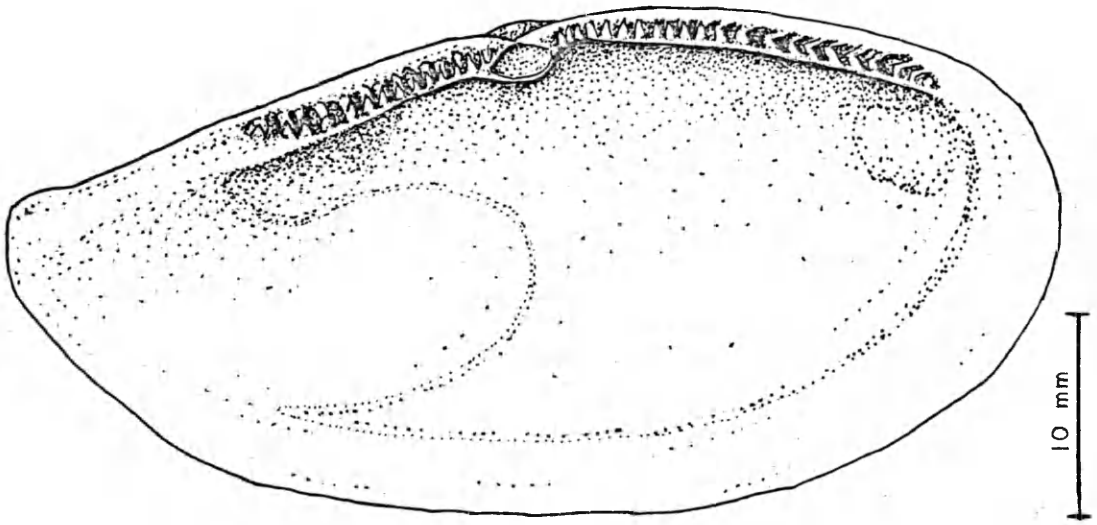


FIG. 4 *Yoldia limatula*

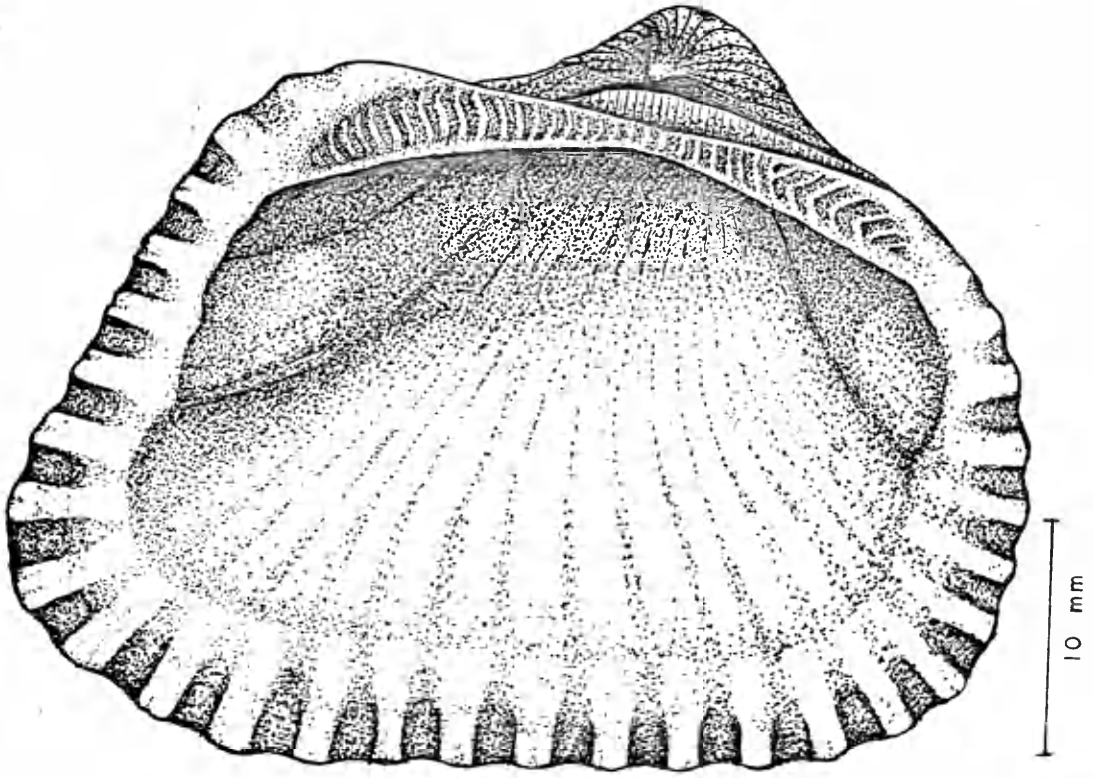


FIG 5 *Noetia ponderosa*

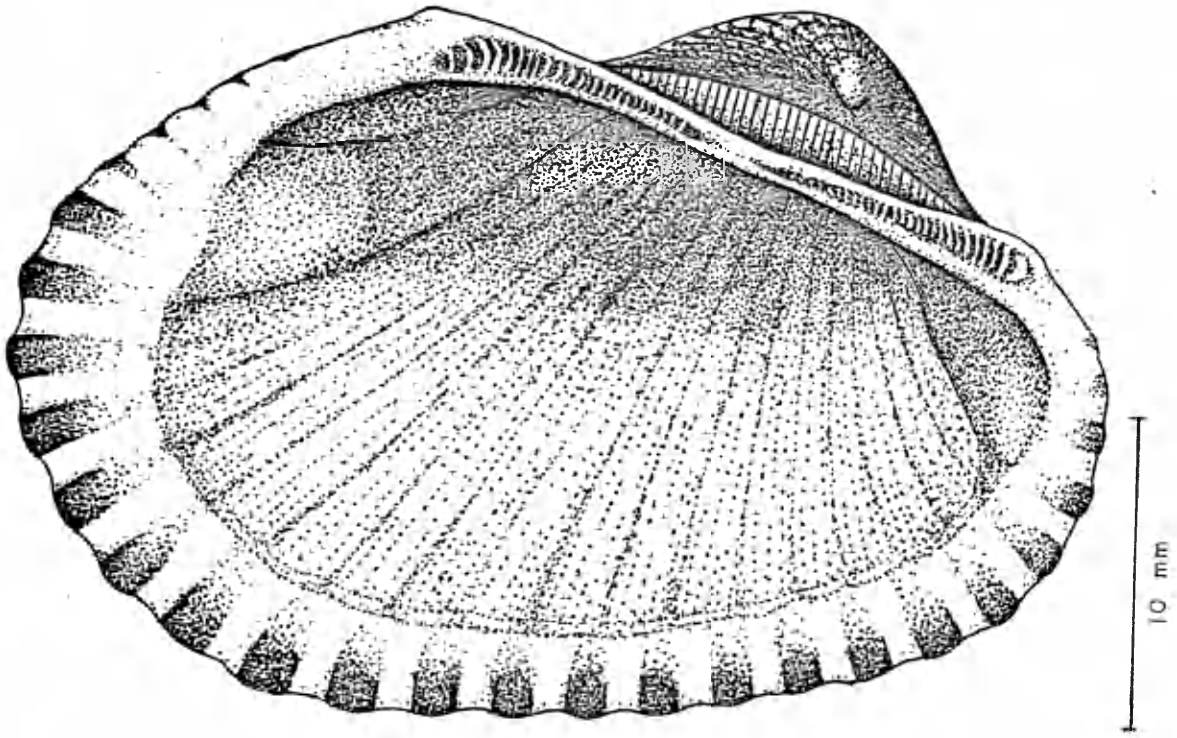


FIG. 6 *Anadara transversa*

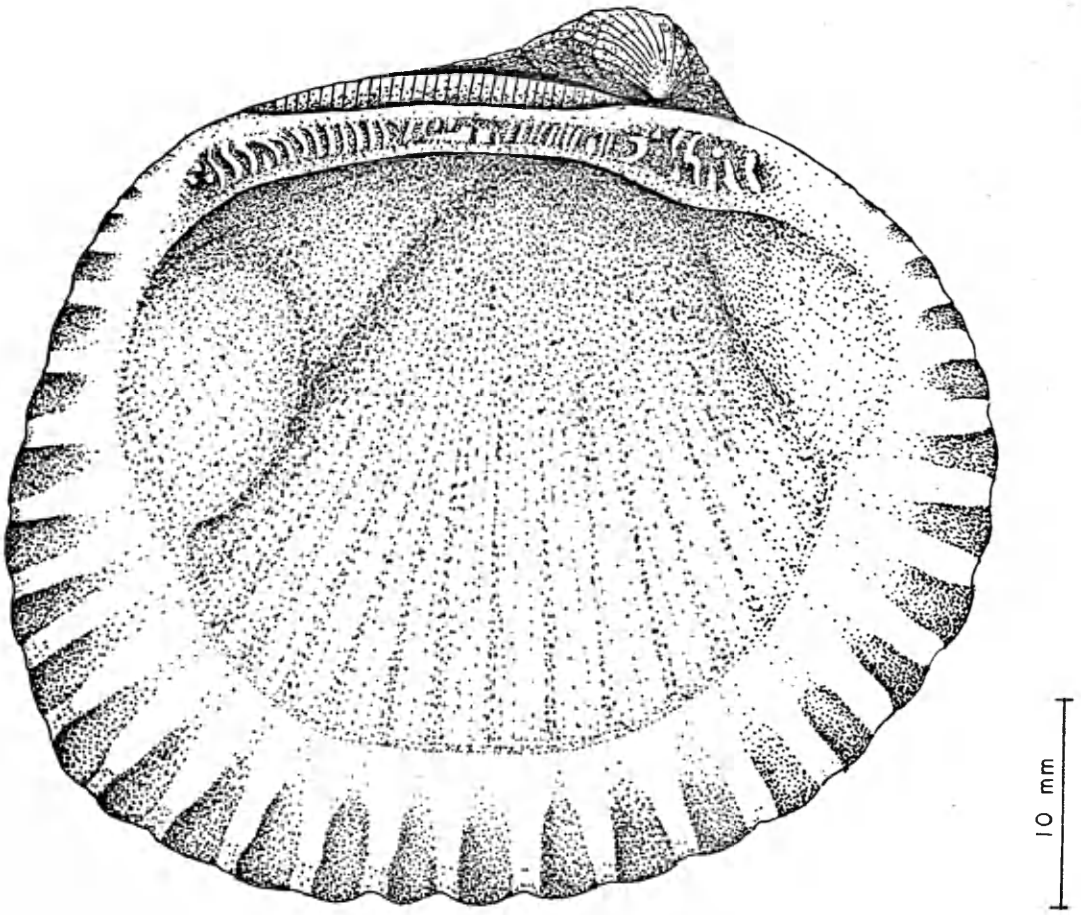


FIG. 7 *Anadara ovalis*

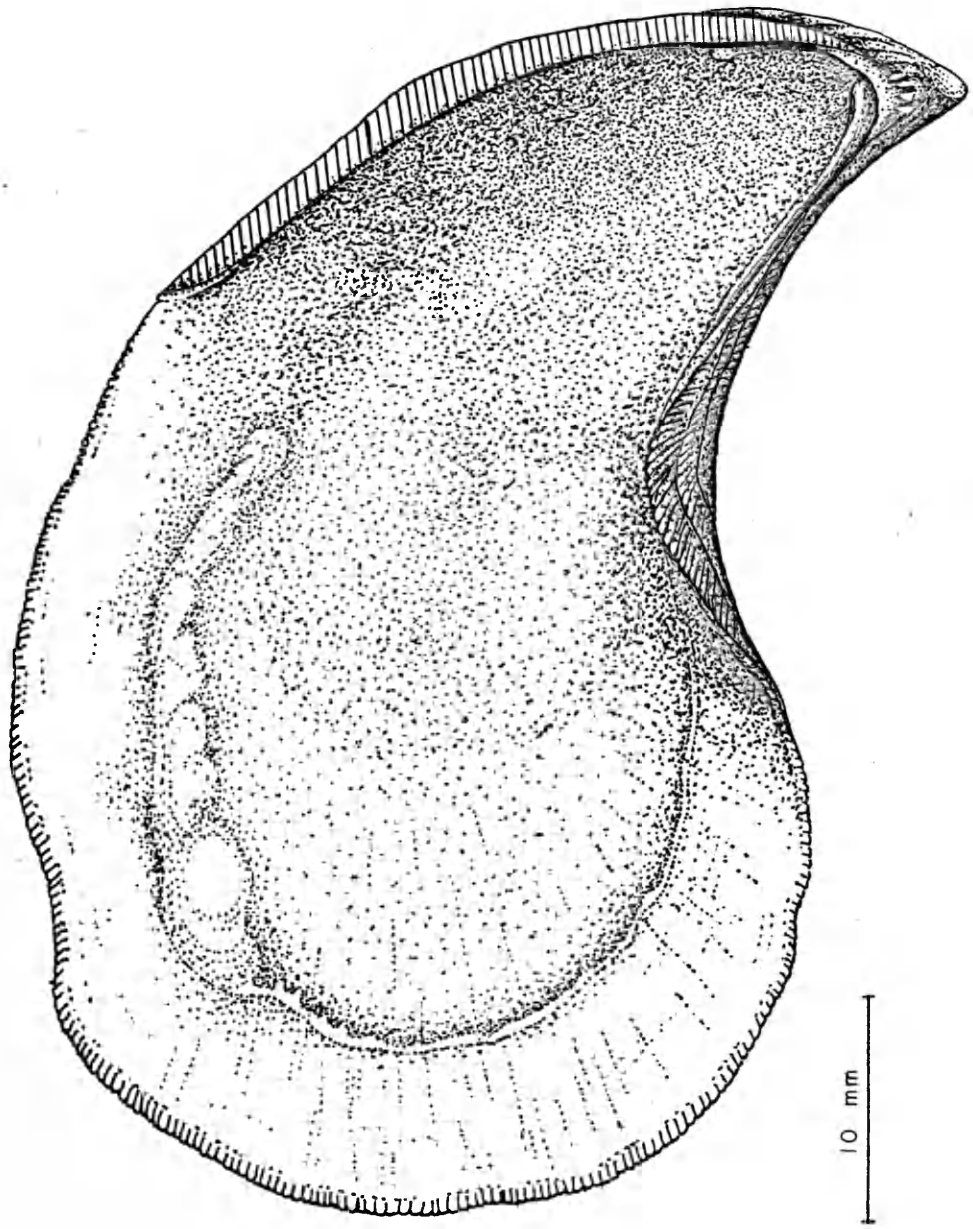


FIG. 8 *Brachidontes recurvus*

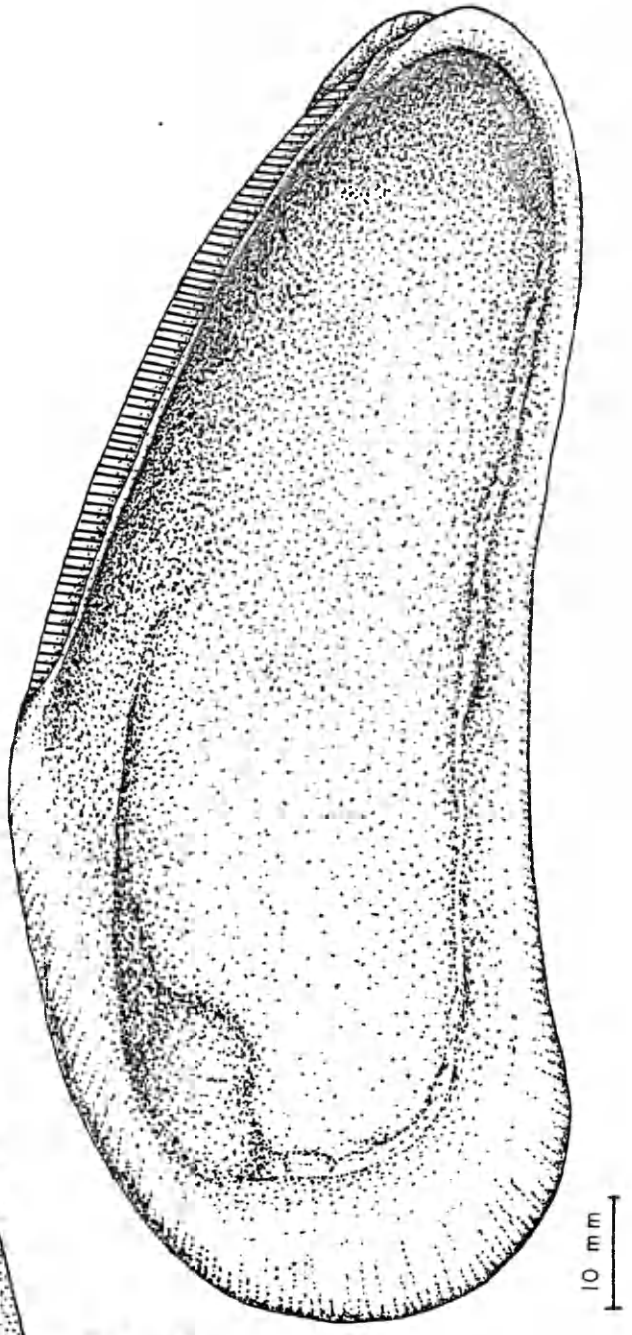


FIG. 9 *Modiolus demissus*

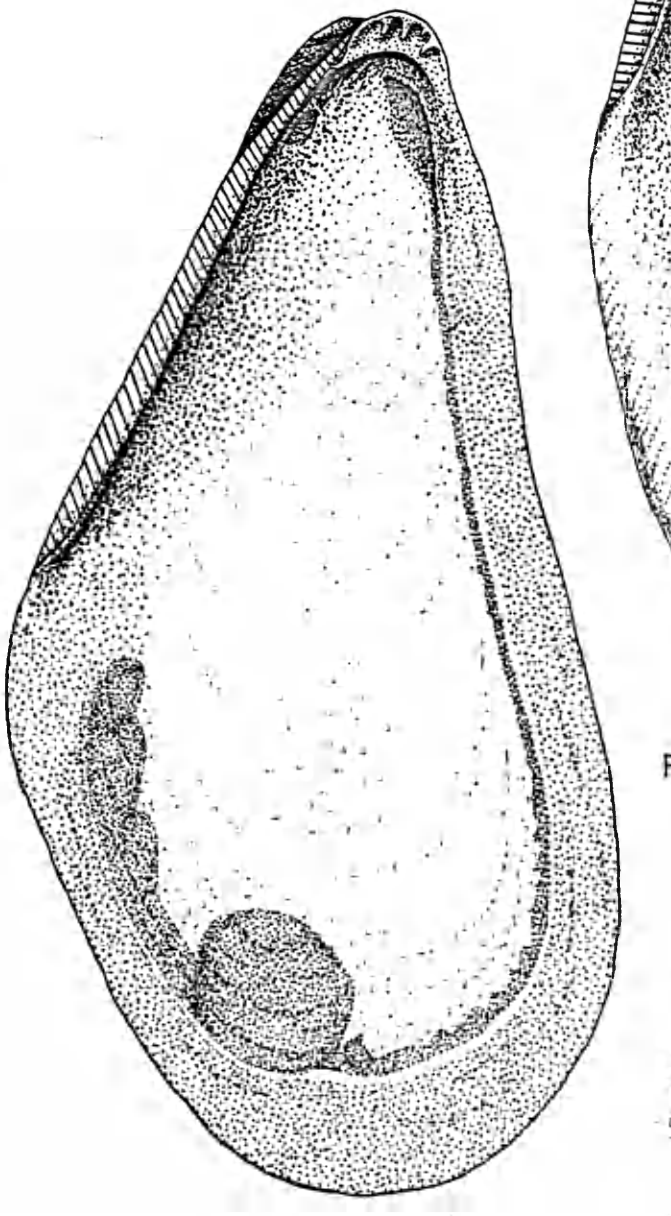


FIG. 10 *Mytilus edulis*

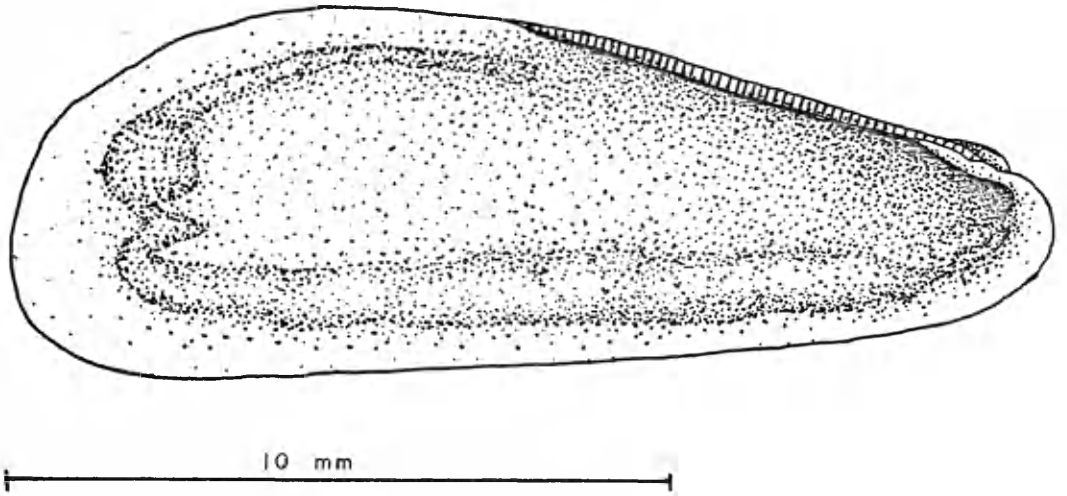


FIG. 11 *Amygdalum papyria*

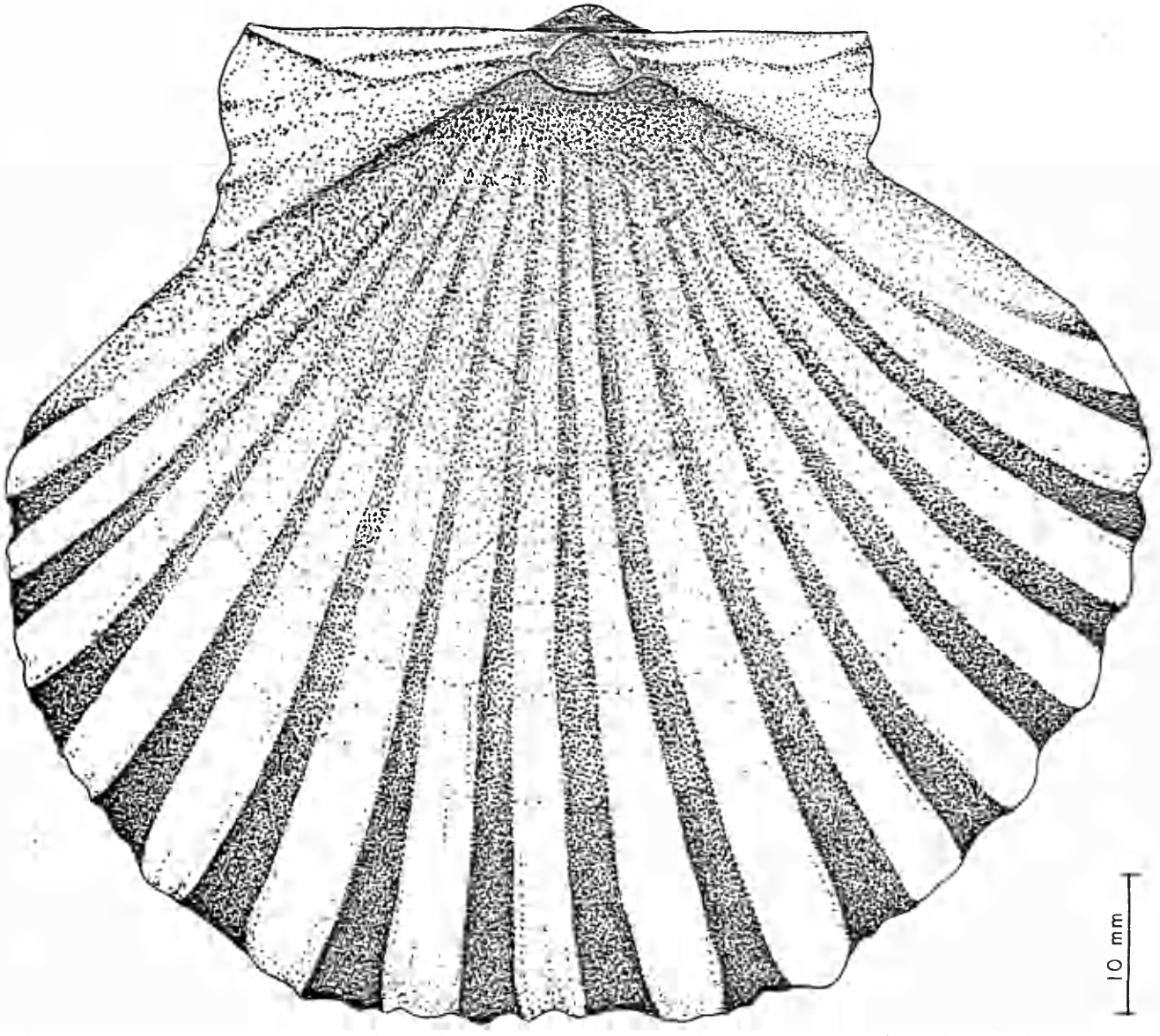


FIG. 12 *Aequipecten irradians*

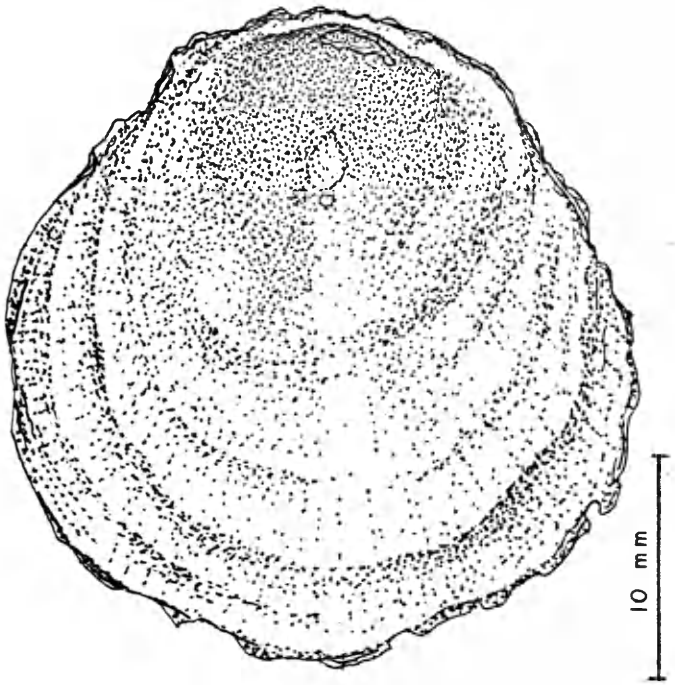


FIG. 13 *Anomia simplex*

FIG. 14 *Crassostrea virginica*

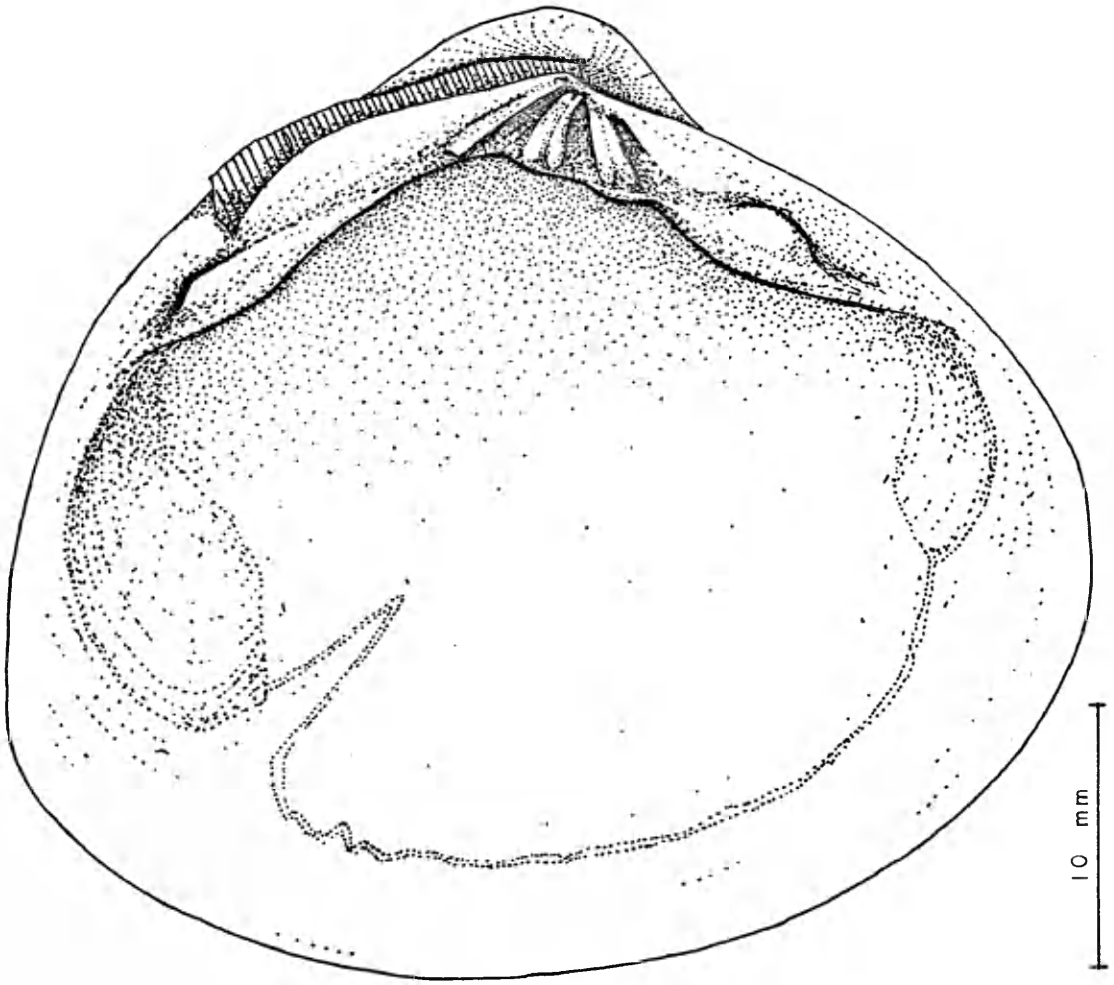


FIG. 15 *Polymesoda caroliniana*

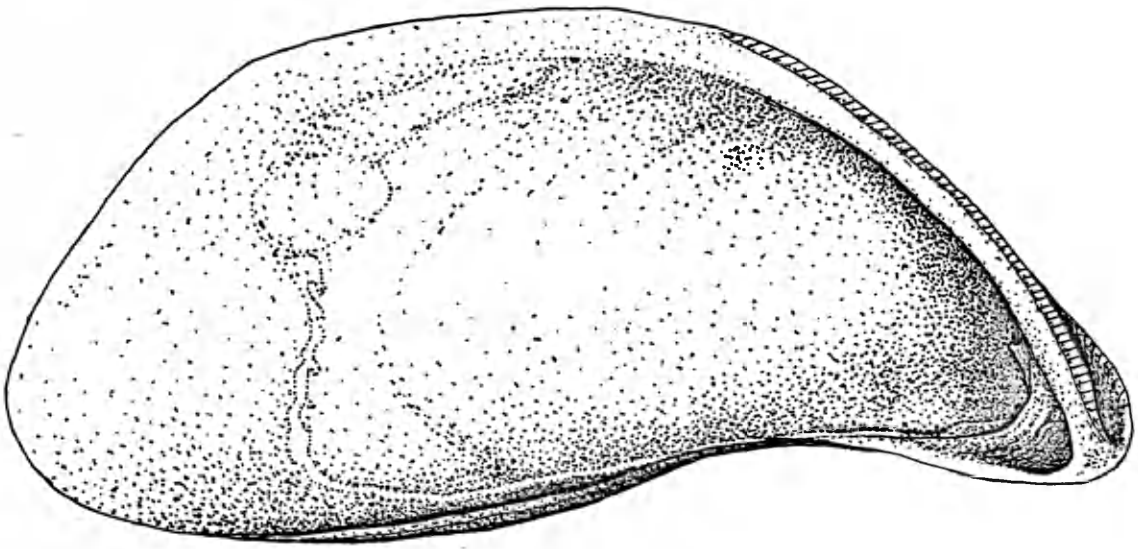


FIG. 16 *Congeria leucophaeata*

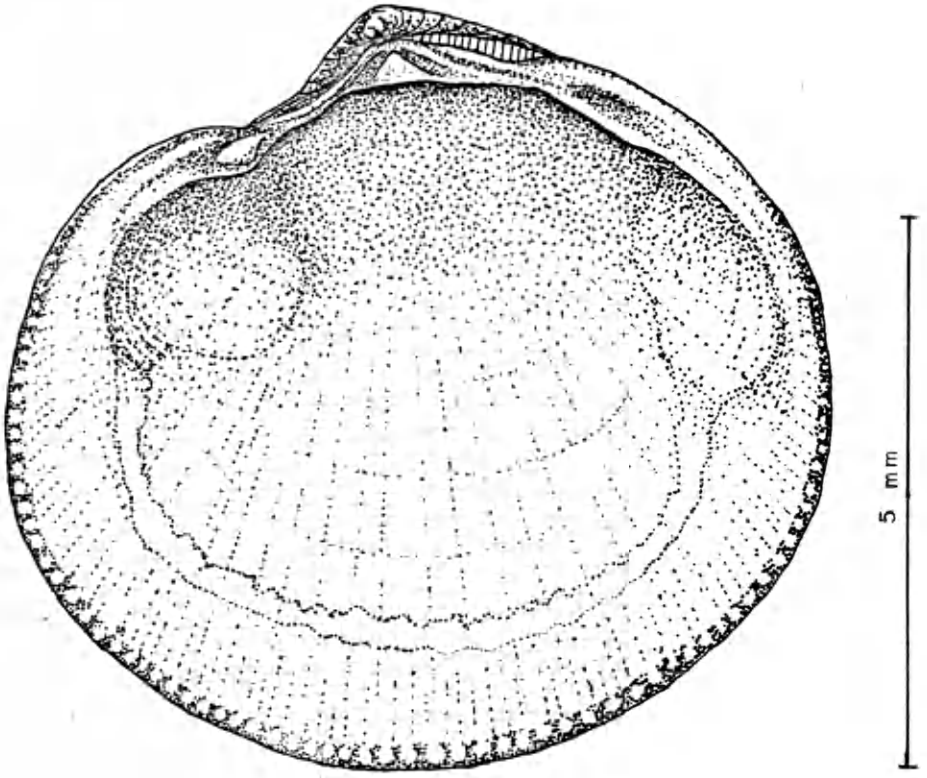


FIG. 17 *Lucina multilineata*

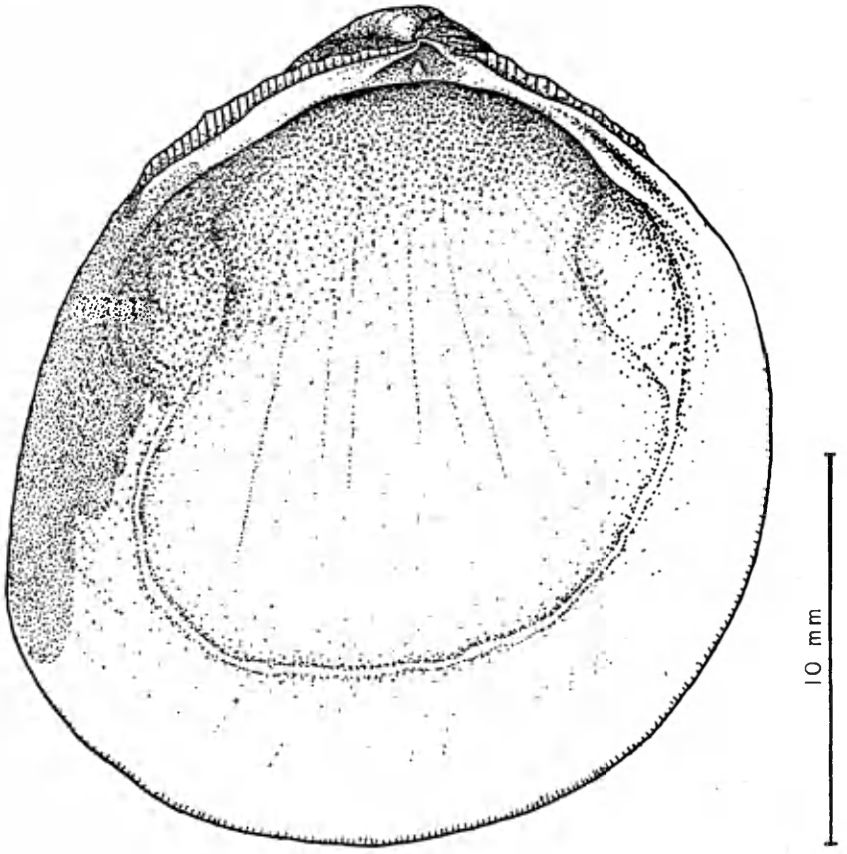


FIG. 18 *Laevicardium mortoni*

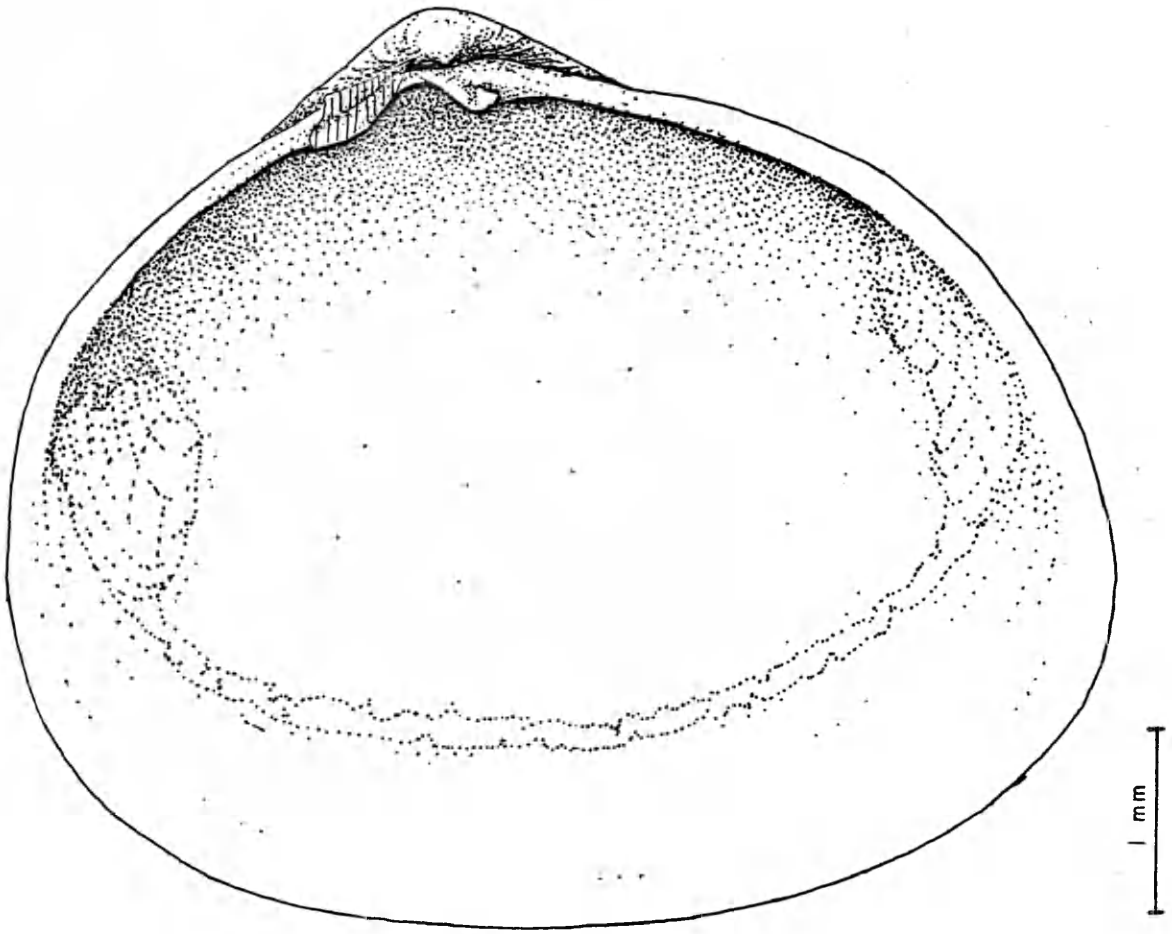


FIG. 19 *Aligena elevata*

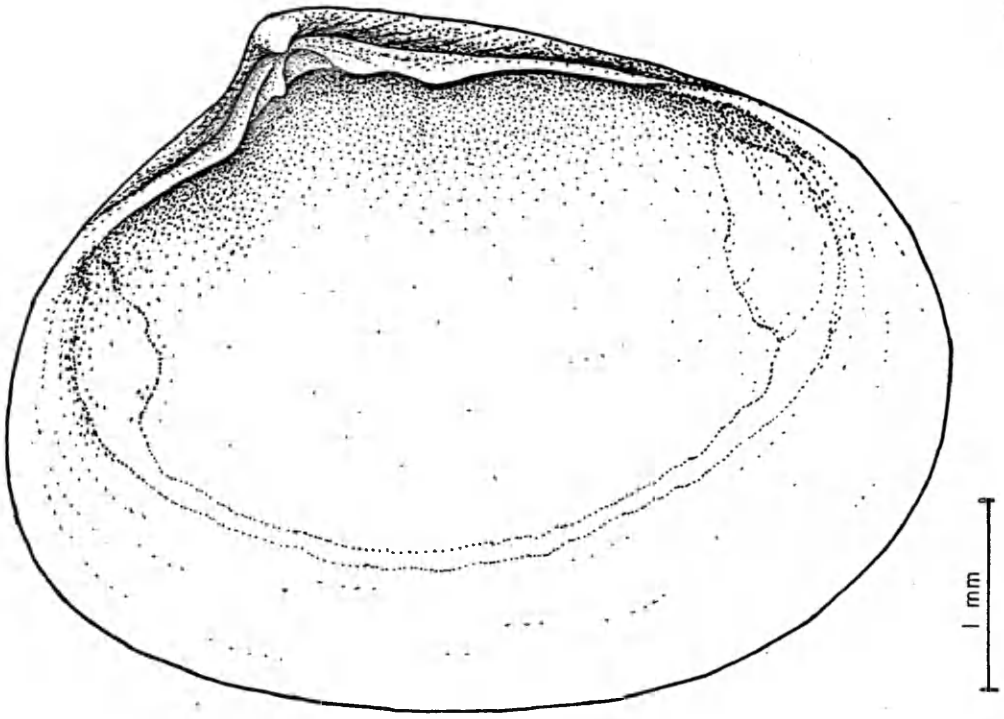


FIG. 20 *Mysella bidentata*

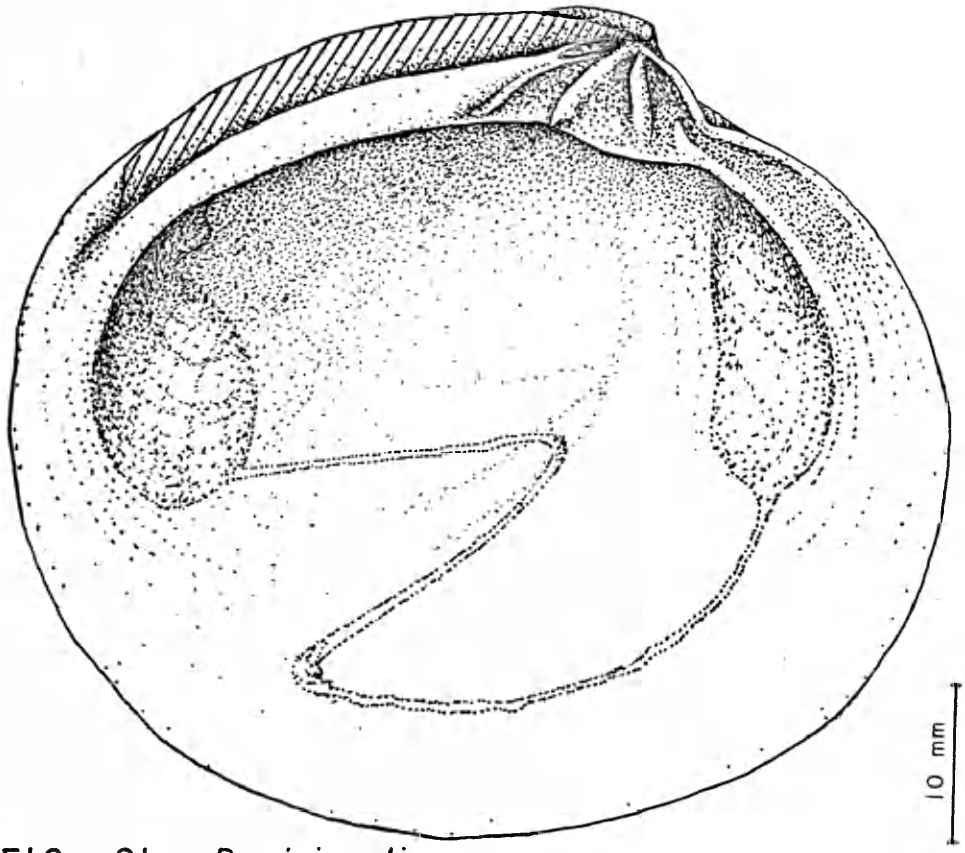


FIG. 21 *Dosinia discus*

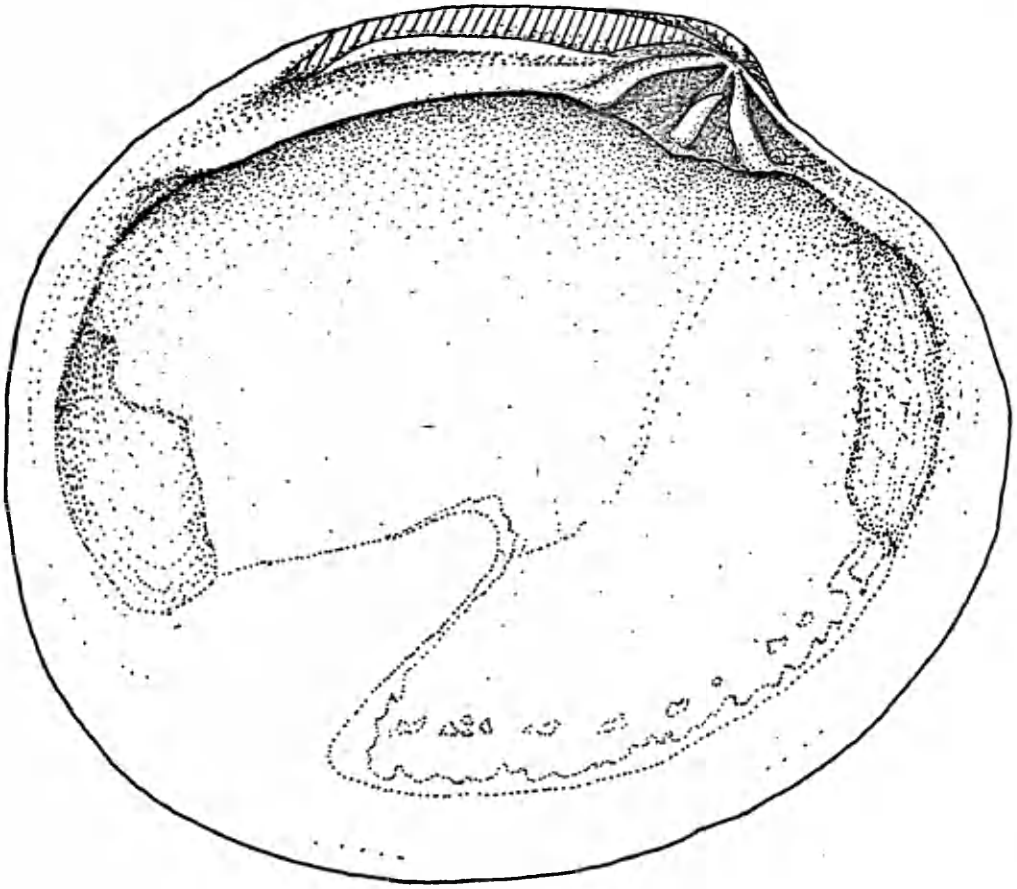


FIG. 22 *Cyclinella tenuis*

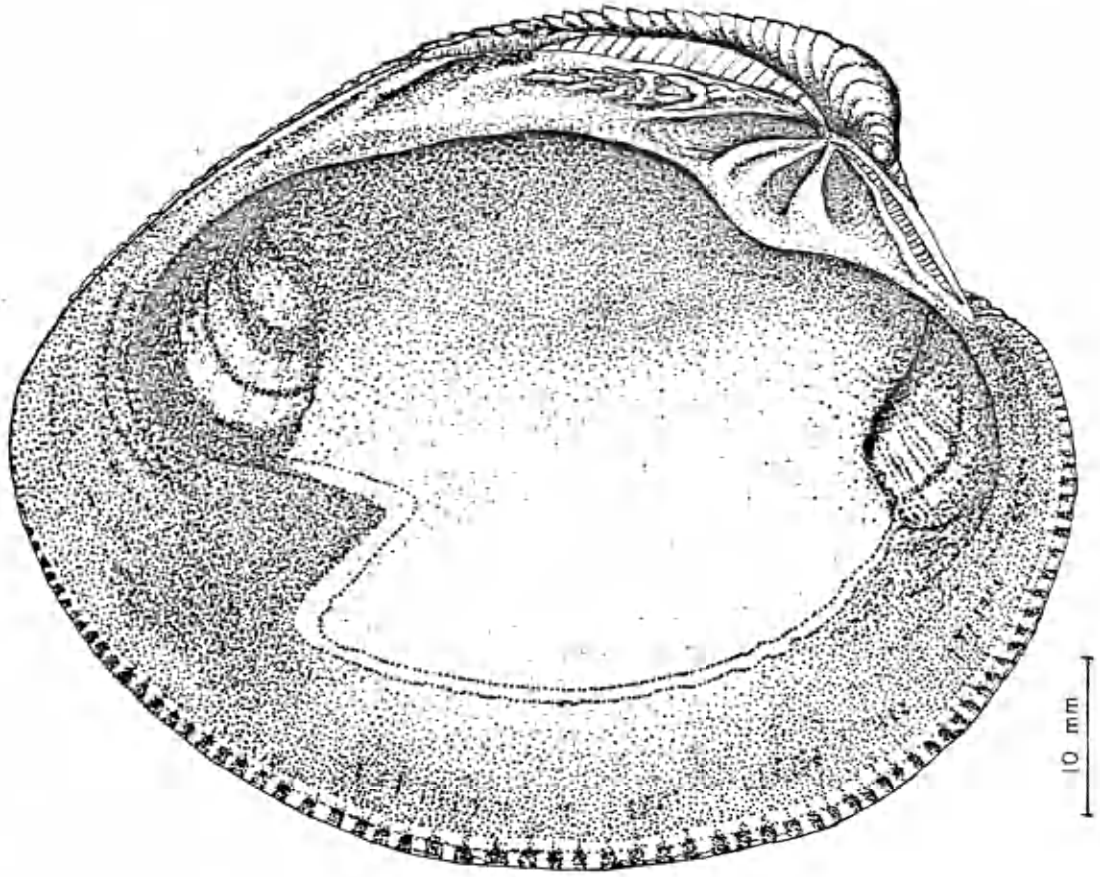


FIG. 23 *Mercenaria mercenaria*

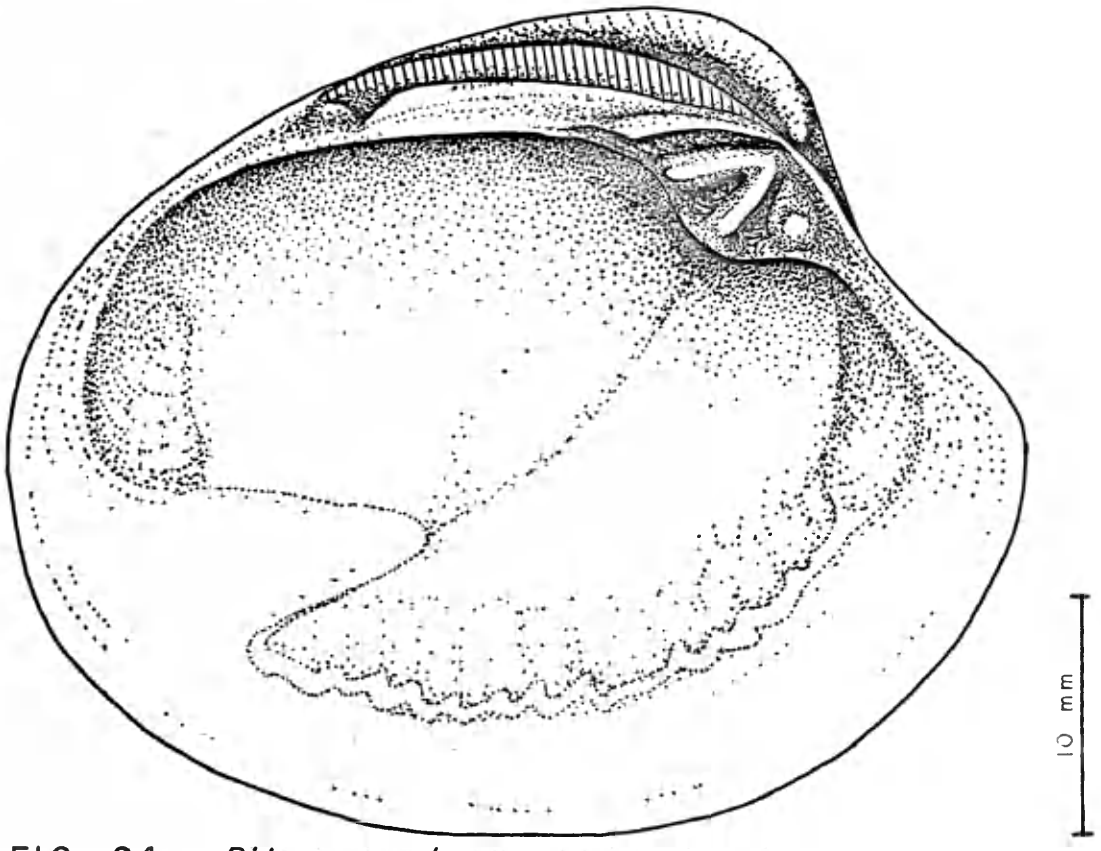


FIG. 24 *Pitar morrhuana*

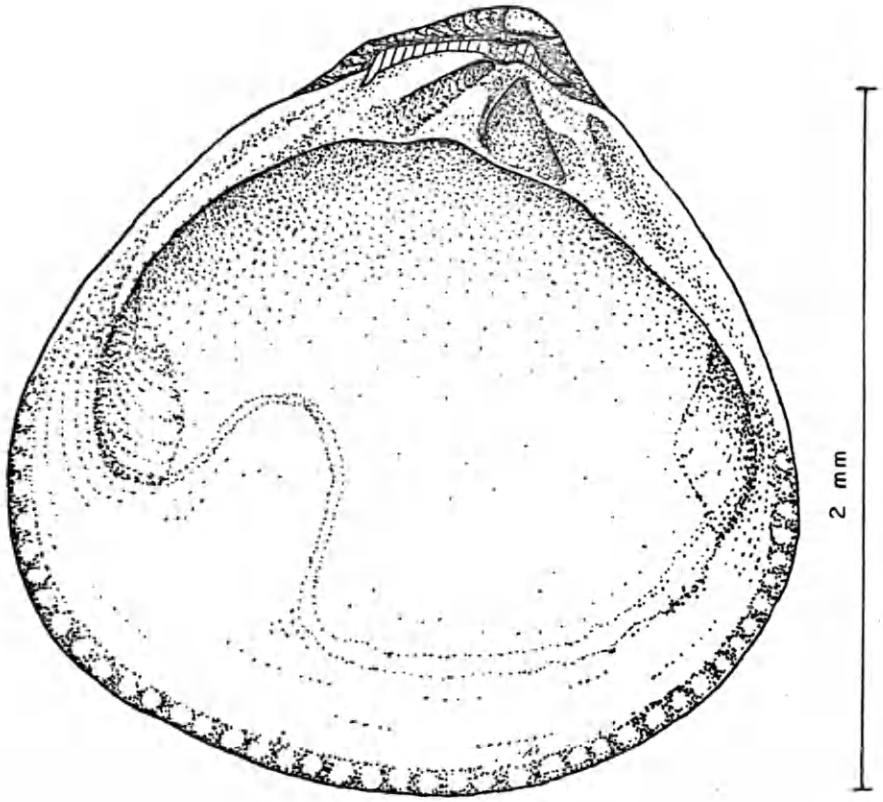


FIG. 25. *Gemma gemma*

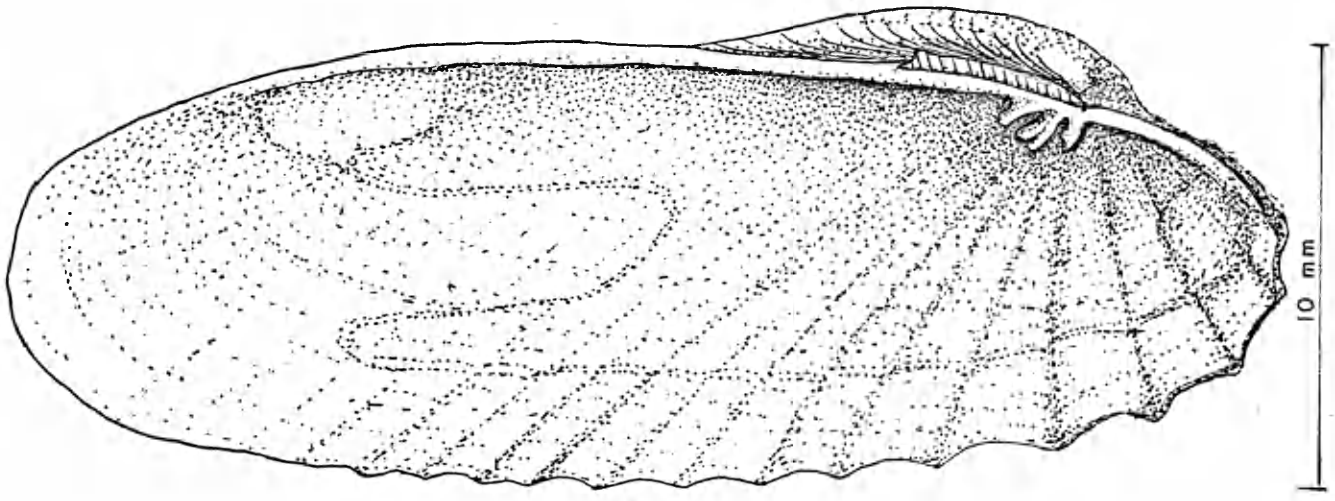


FIG. 26 *Petricola pholadiformis*

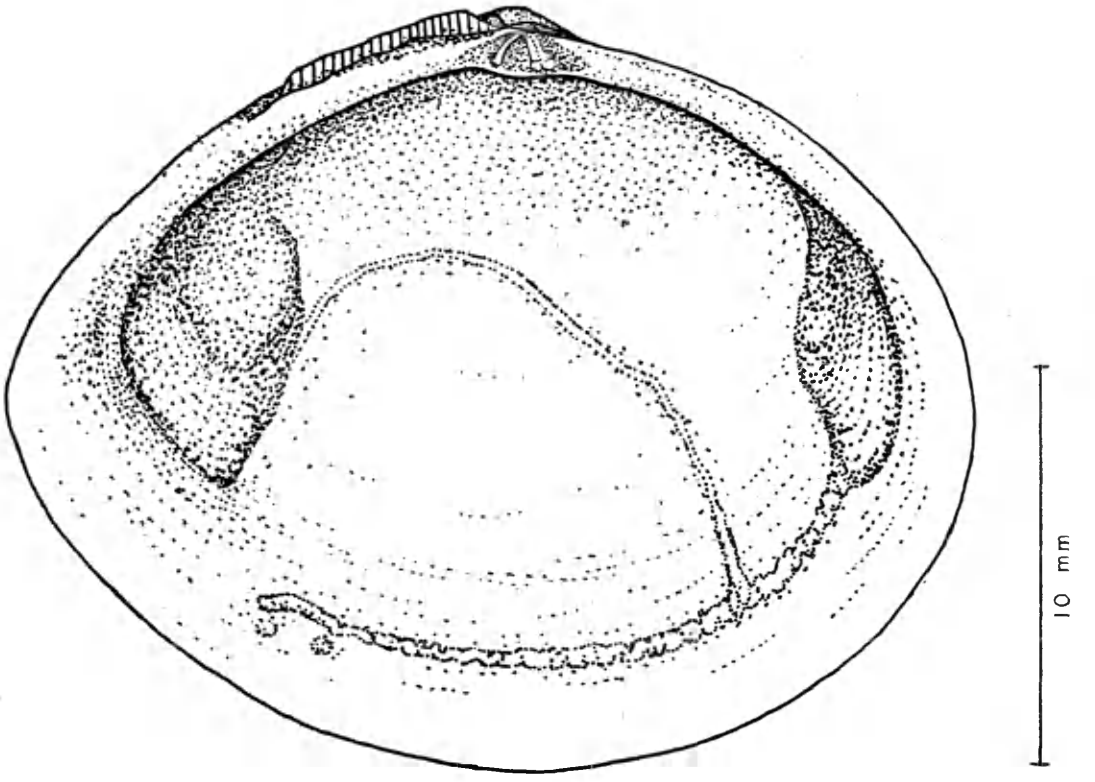


FIG. 27 *Macoma balthica*

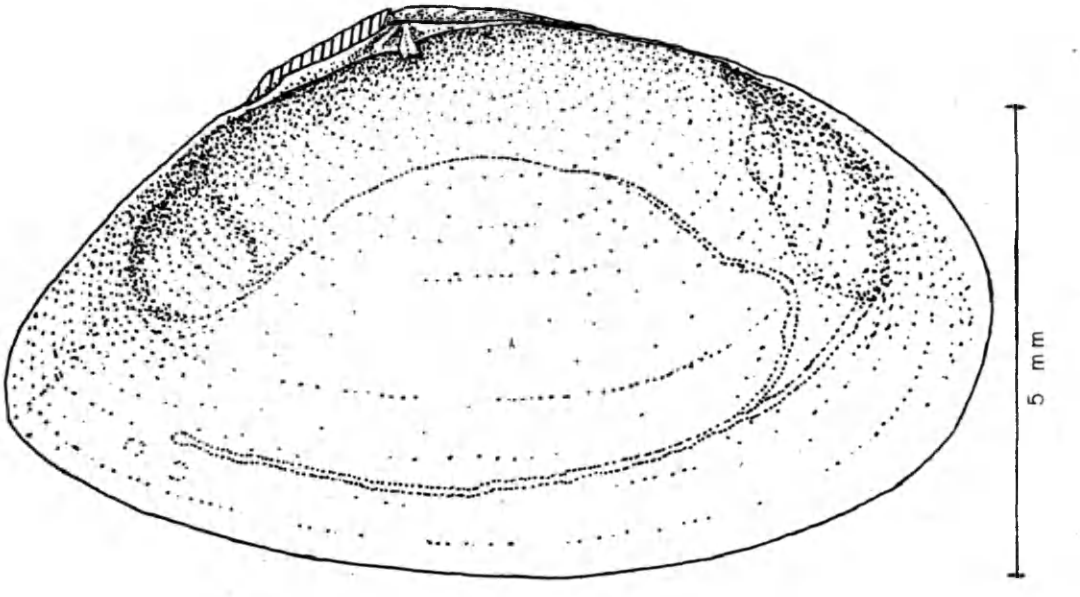


FIG. 28 *Tellina agilis*

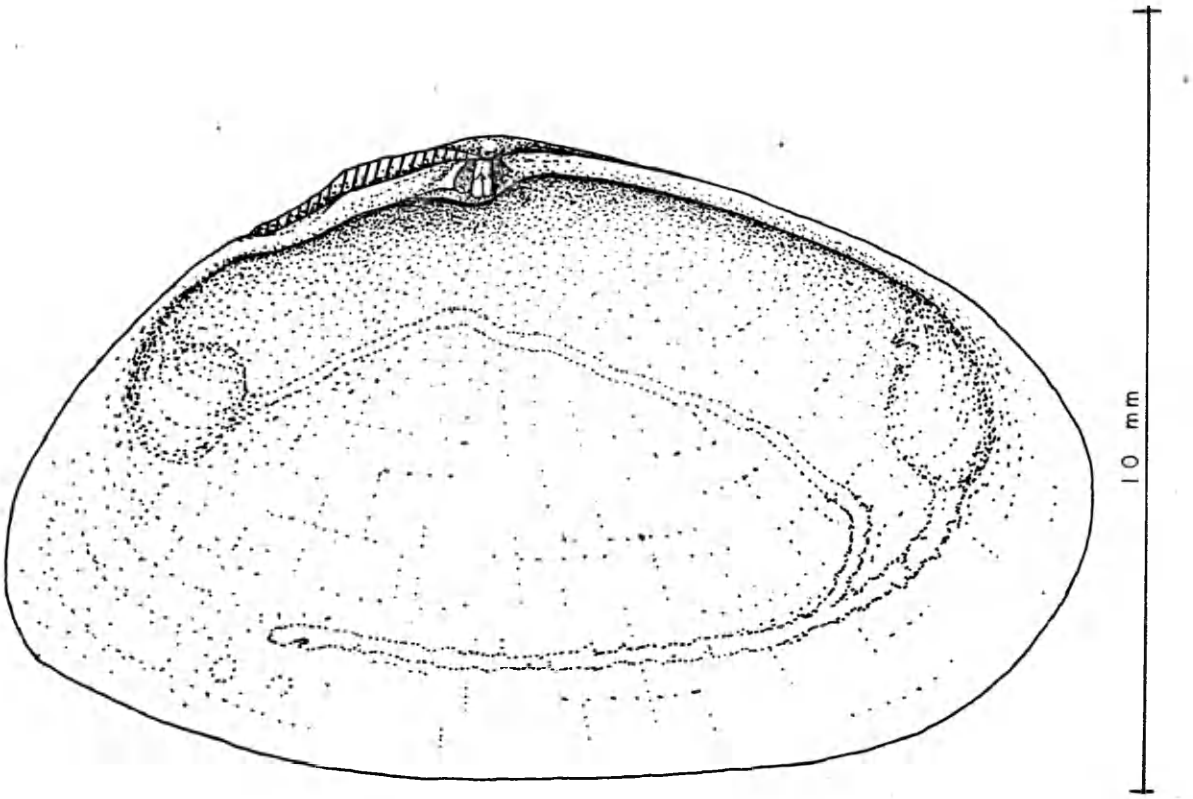


FIG. 29 *Macoma phenax*

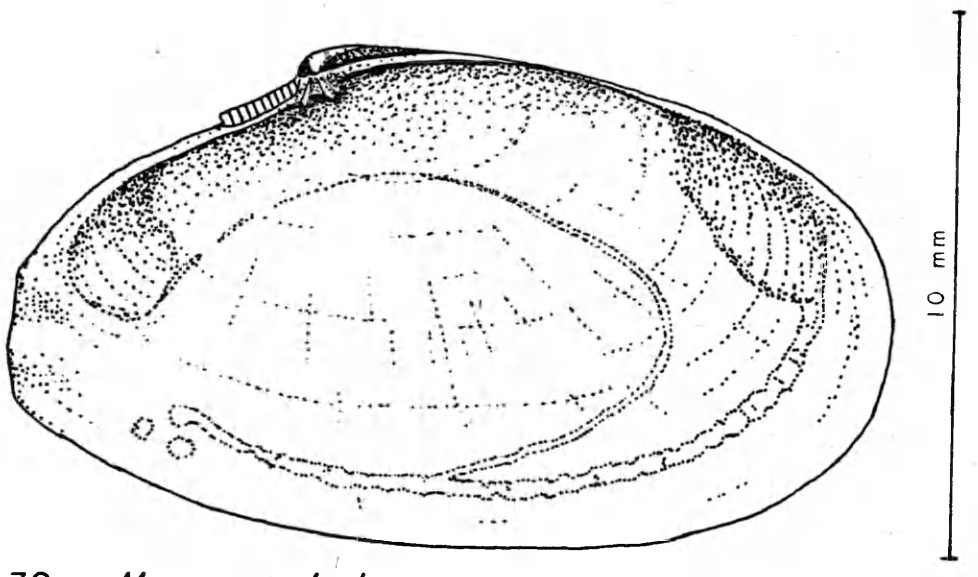


FIG. 30 *Macoma tenta*

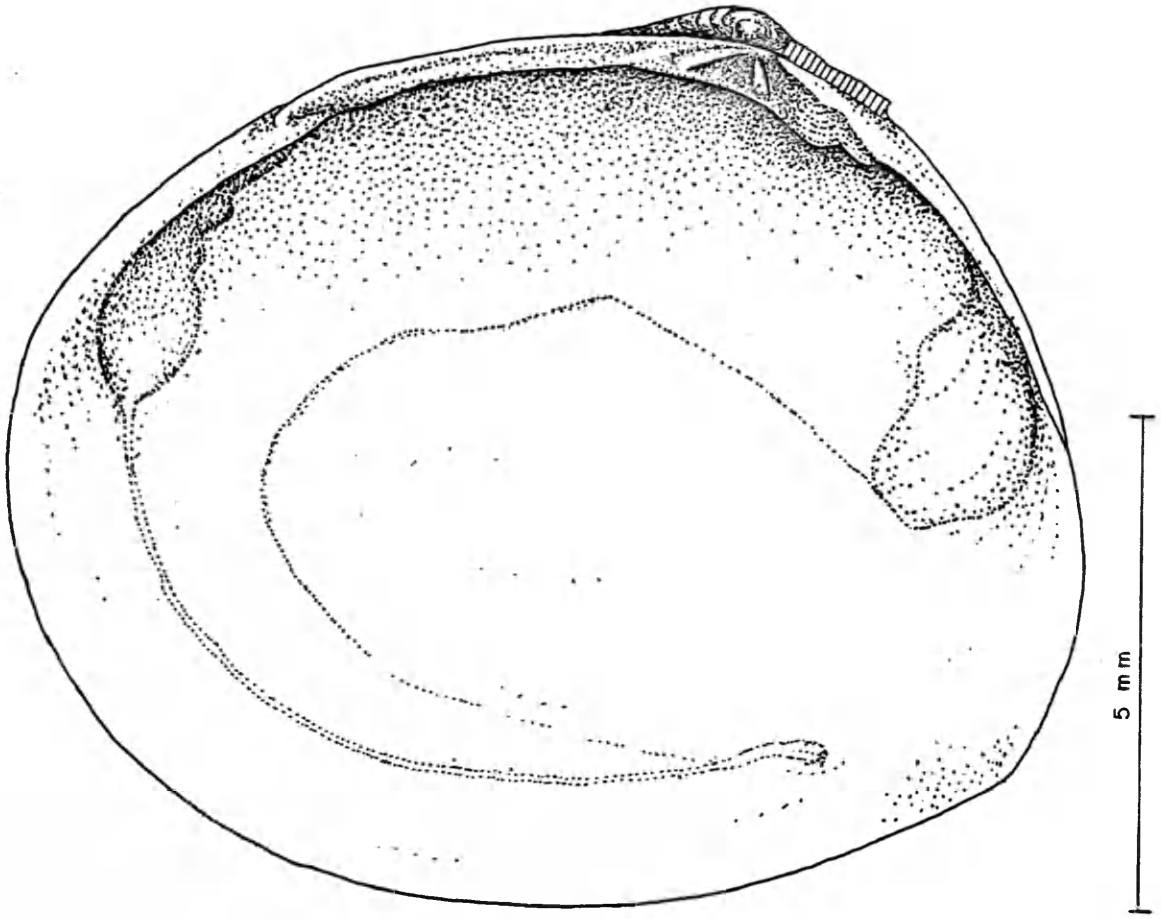


FIG. 31 *Abra aequalis*

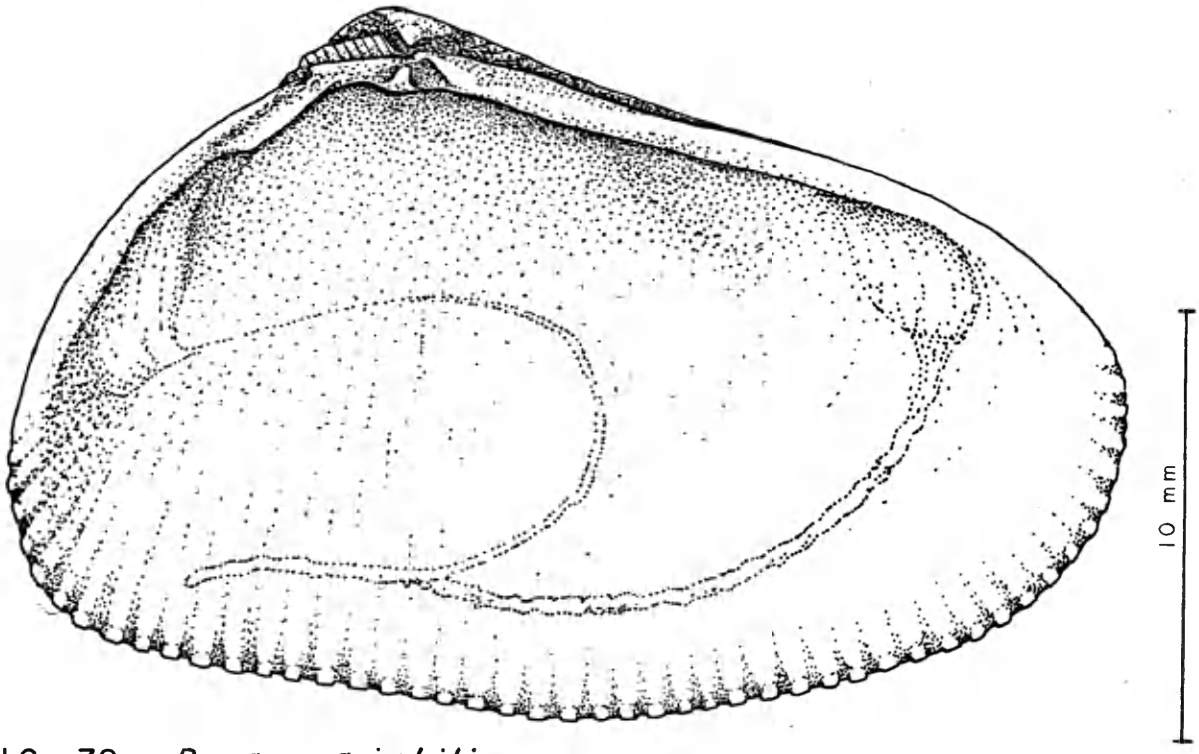


FIG. 32 *Donax variabilis*

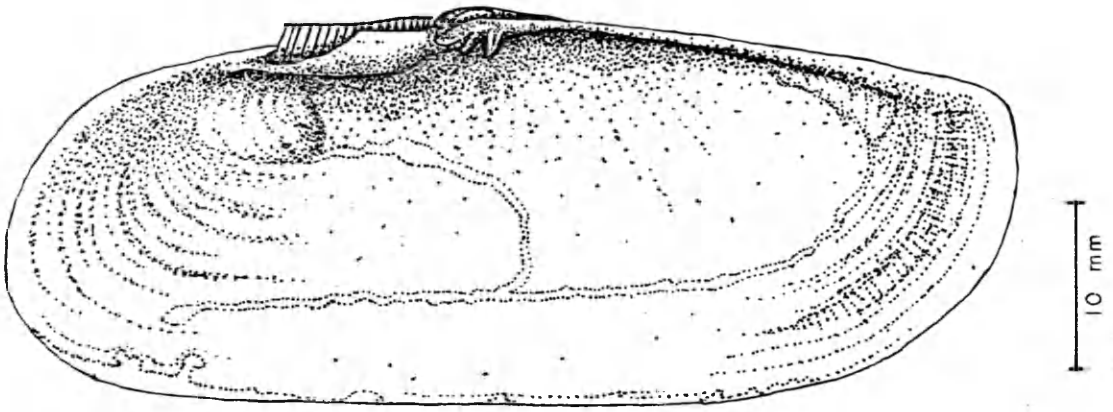


FIG. 33 *Tagelus plebeius*

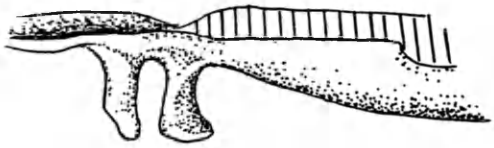


FIG. 34b

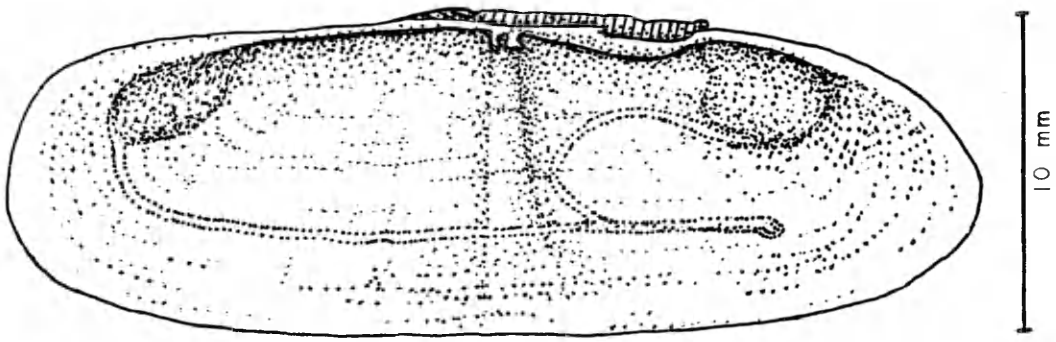


FIG. 34a *Tagelus divisus*

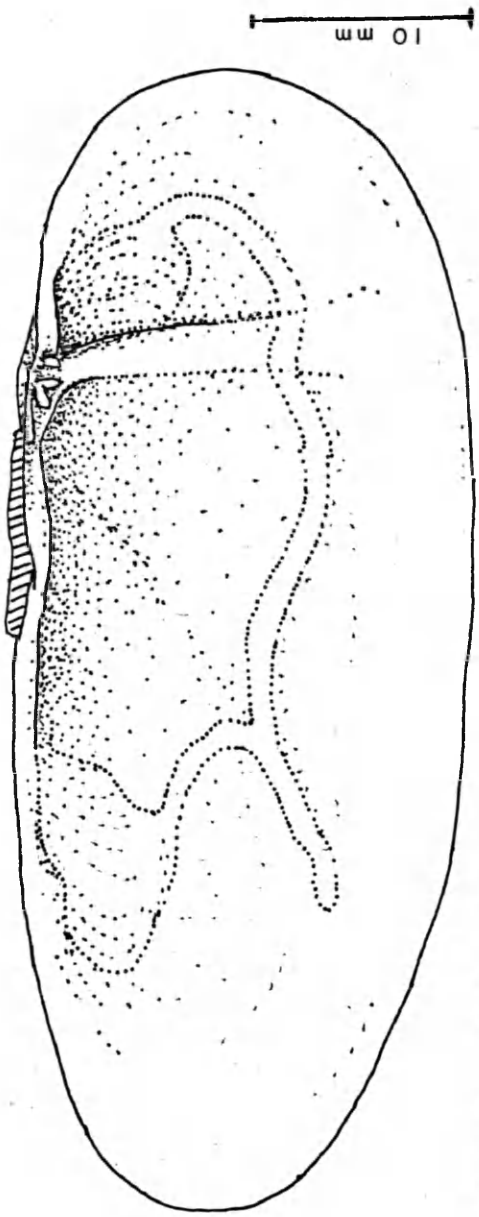


FIG. 35 *Siliqua costata*

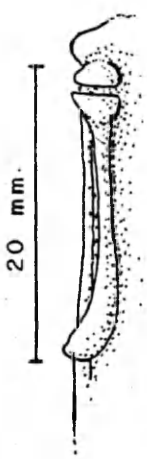


FIG. 36b

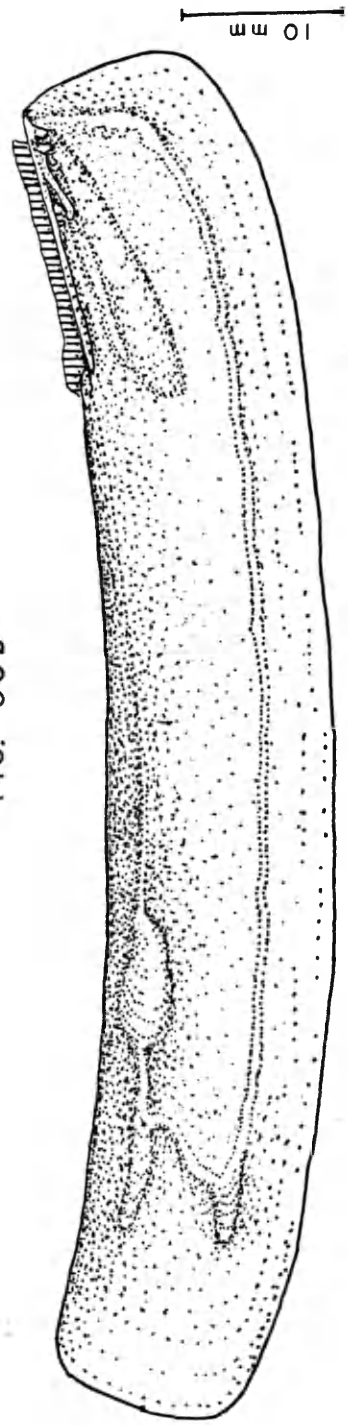


FIG. 36a *Ensis directus*

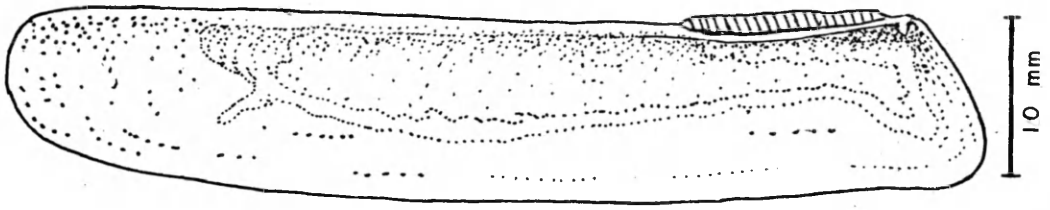


FIG. 37 *Solen viridus*

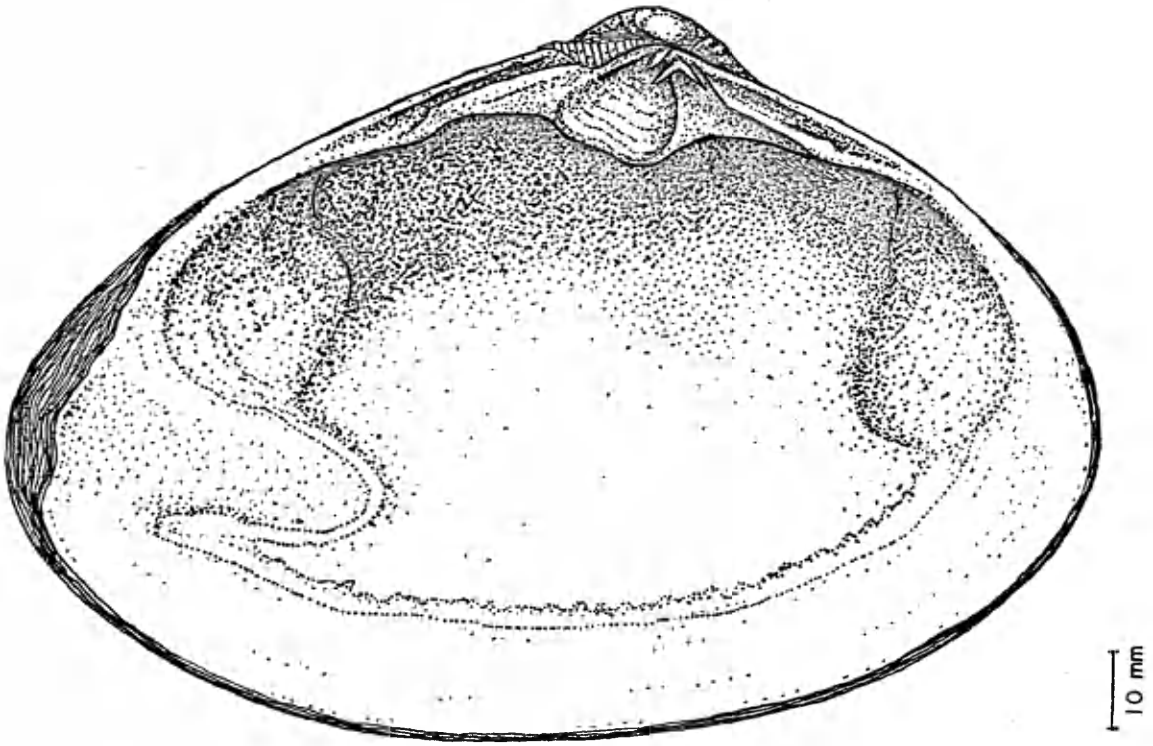


FIG. 38 *Spisula solidissima*

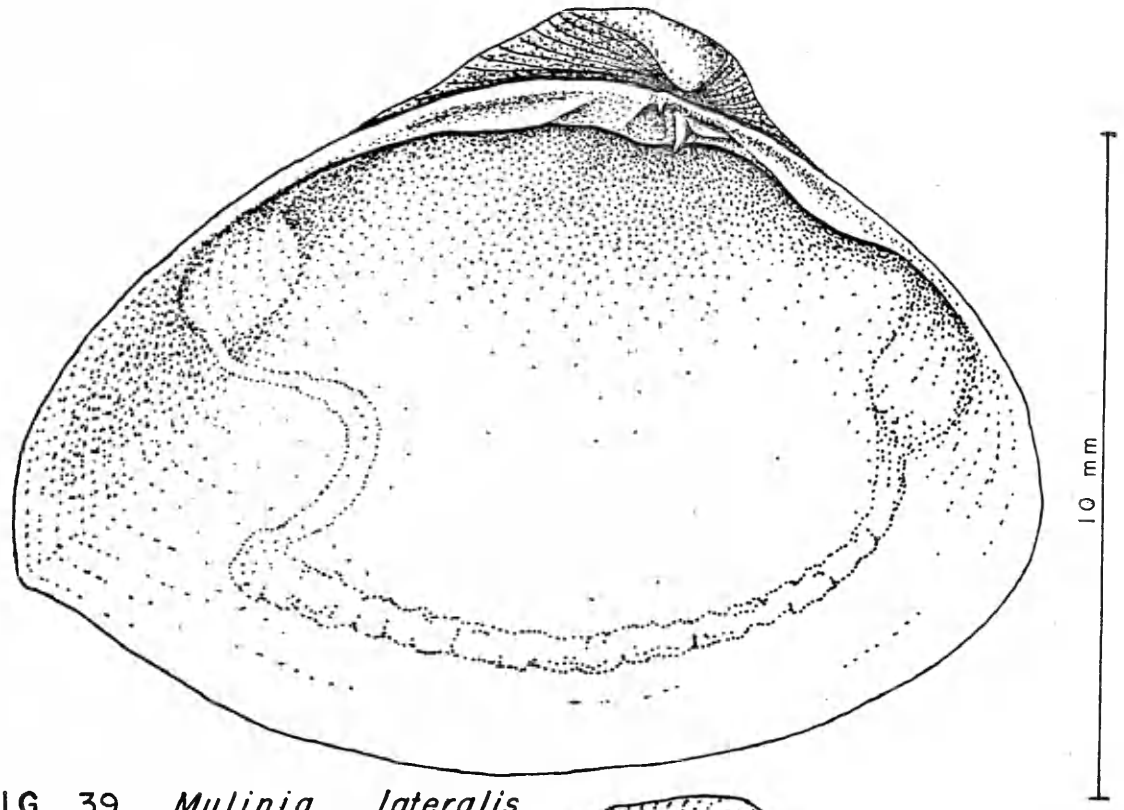


FIG. 39 *Mulinia lateralis*

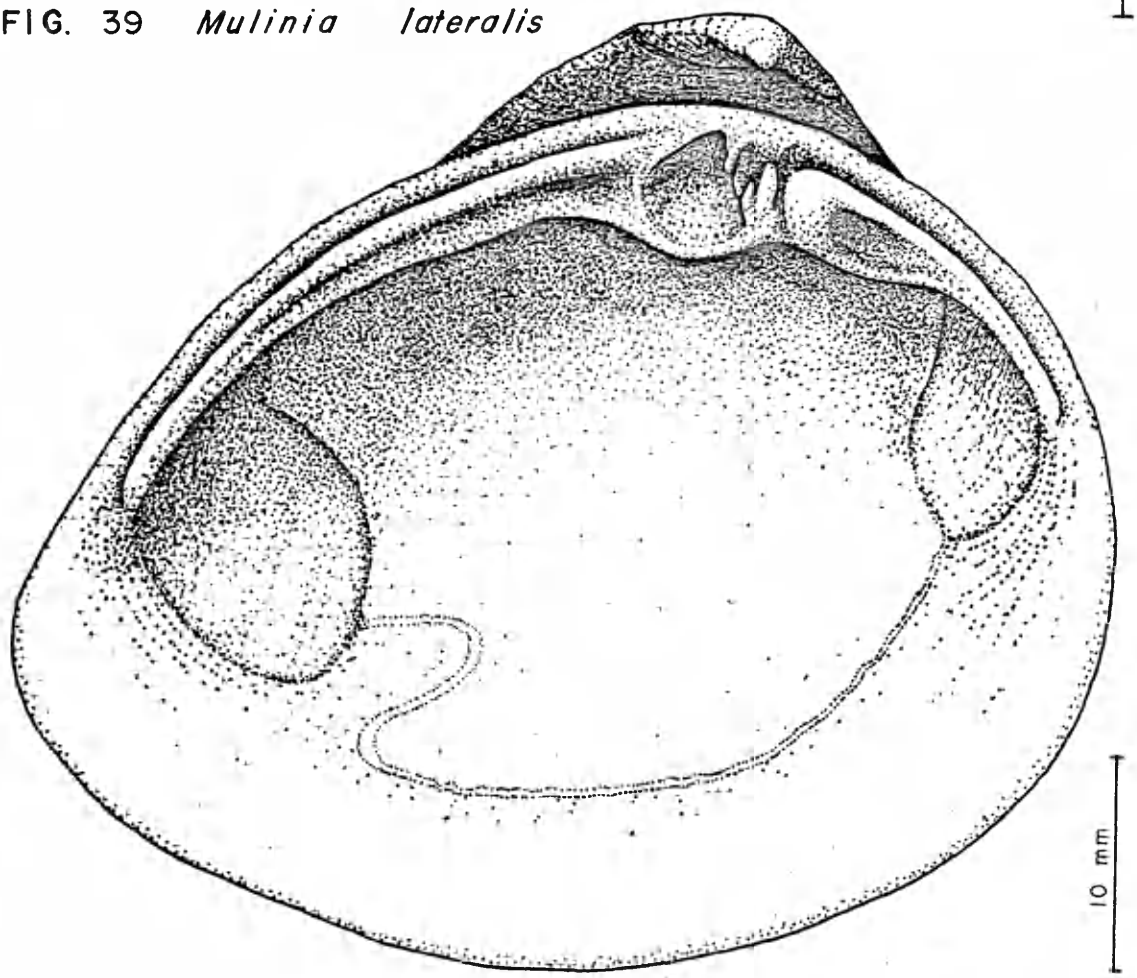


FIG. 40 *Rangia cuneata*

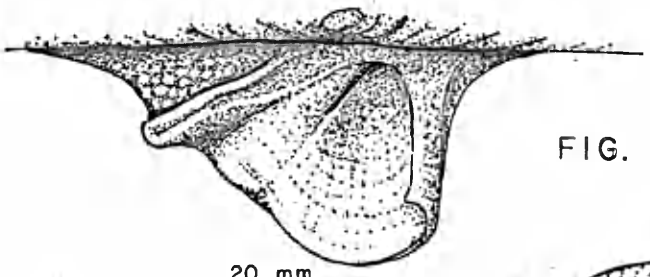


FIG. 41b.

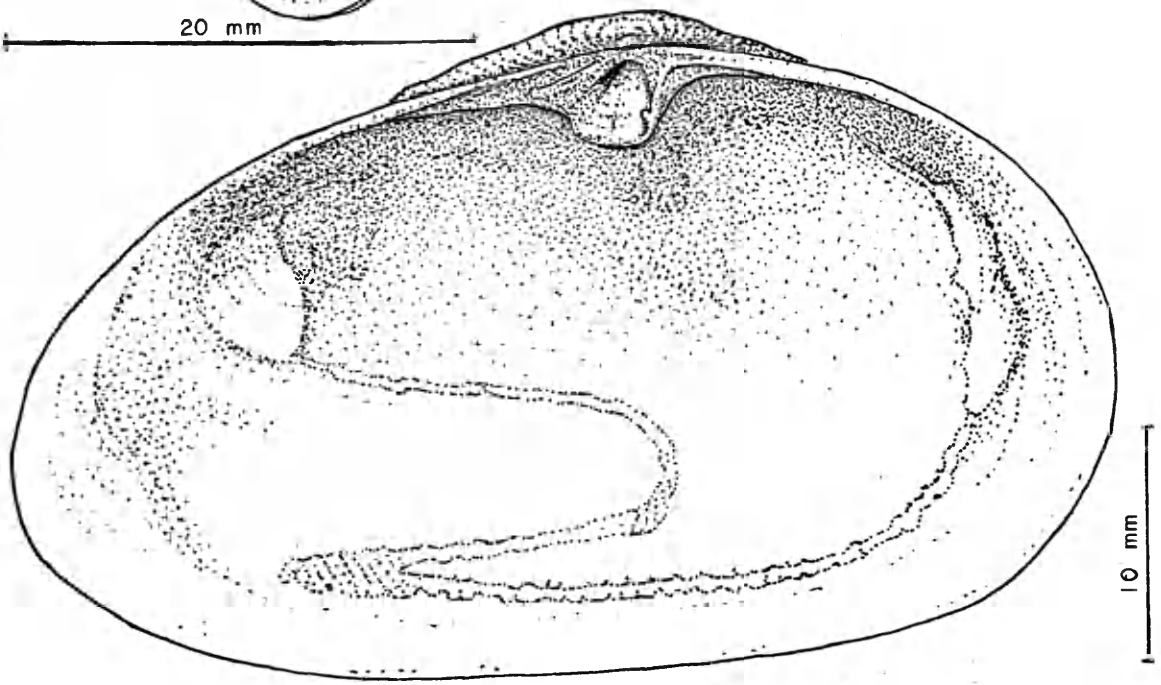


FIG. 41a. *Mya arenaria*

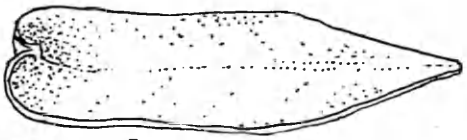


FIG. 42b.

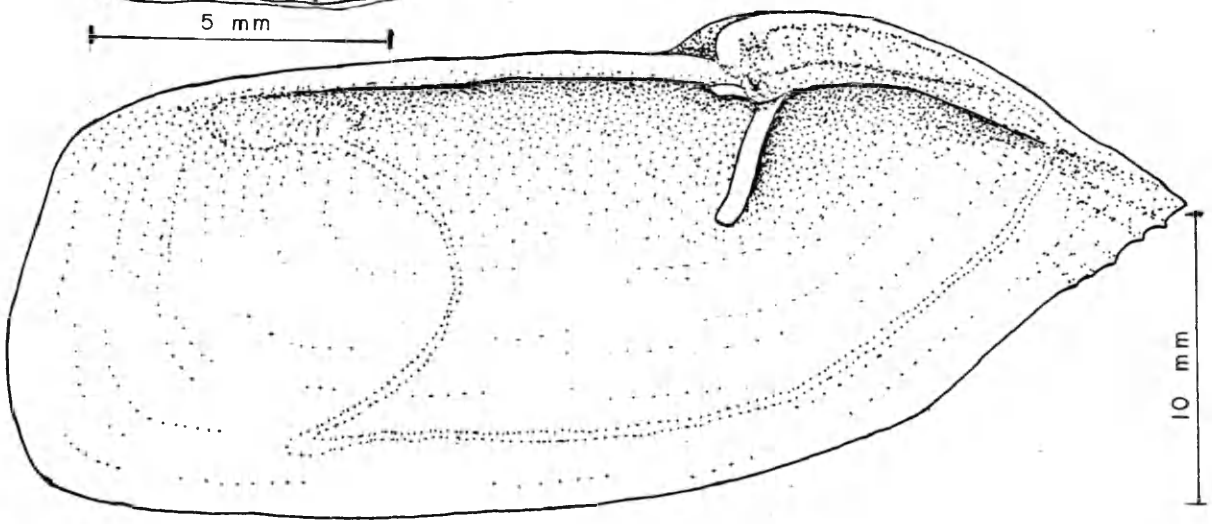


FIG. 42a. *Barnea truncata*

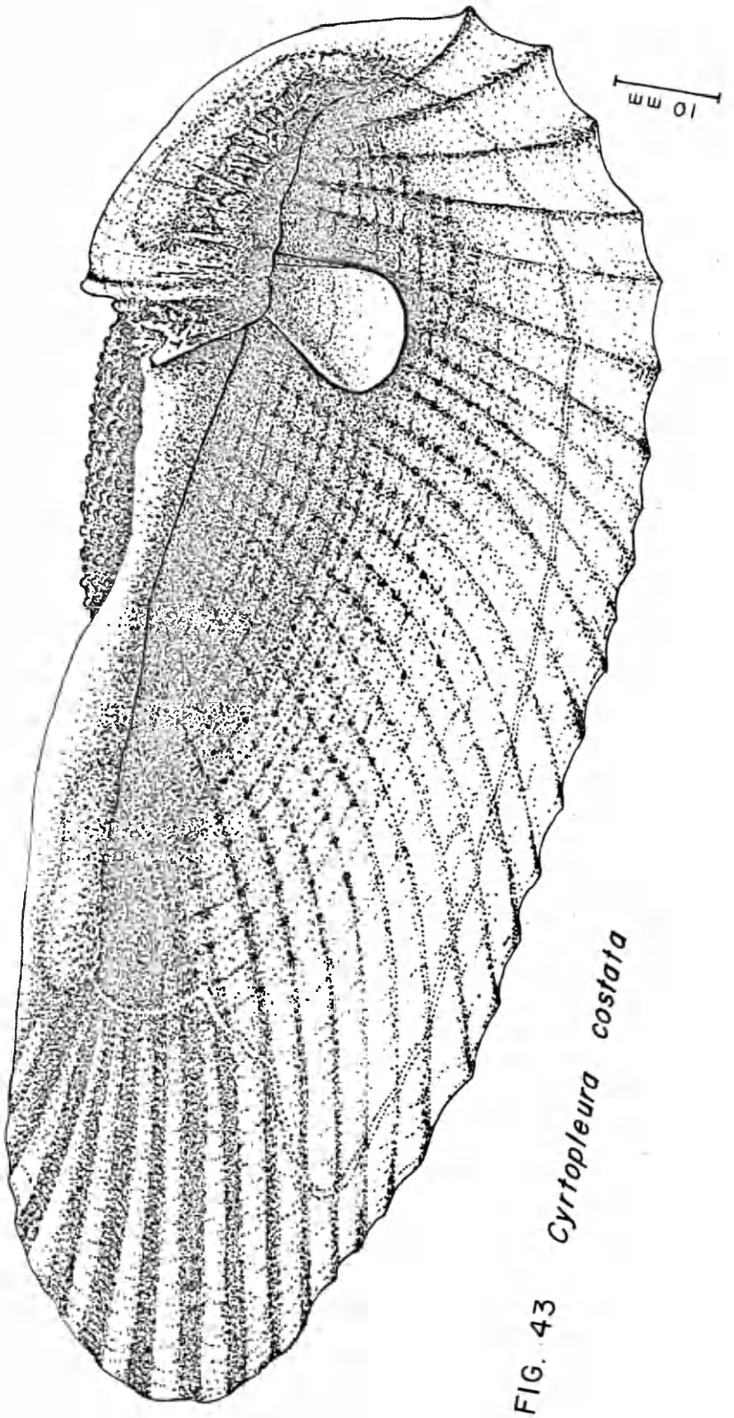
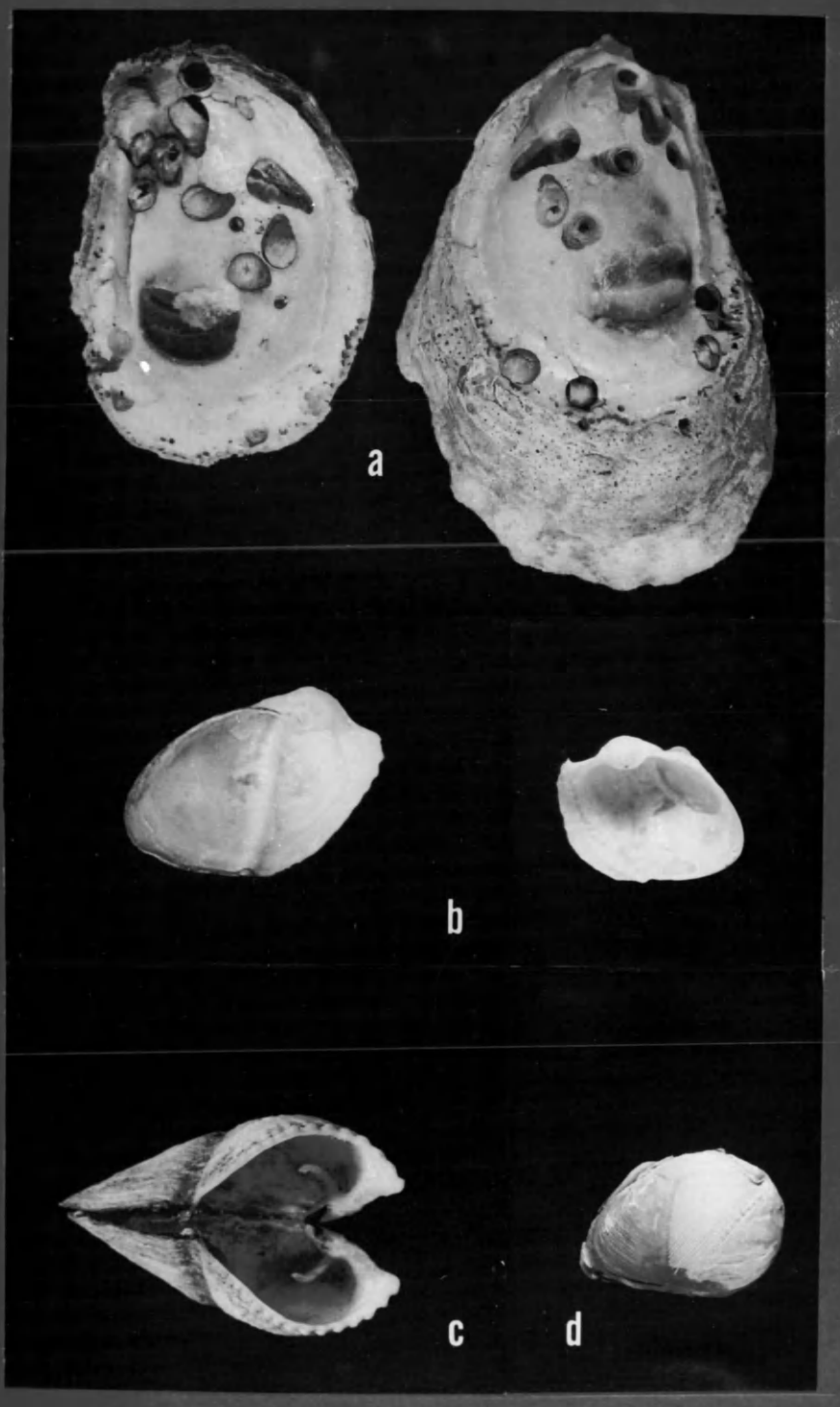
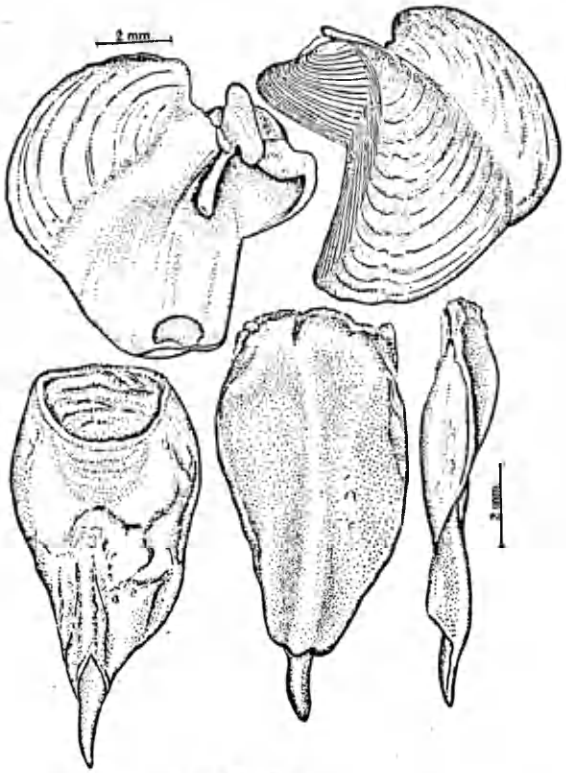


FIG. 43 *Cyrtopleura costata*

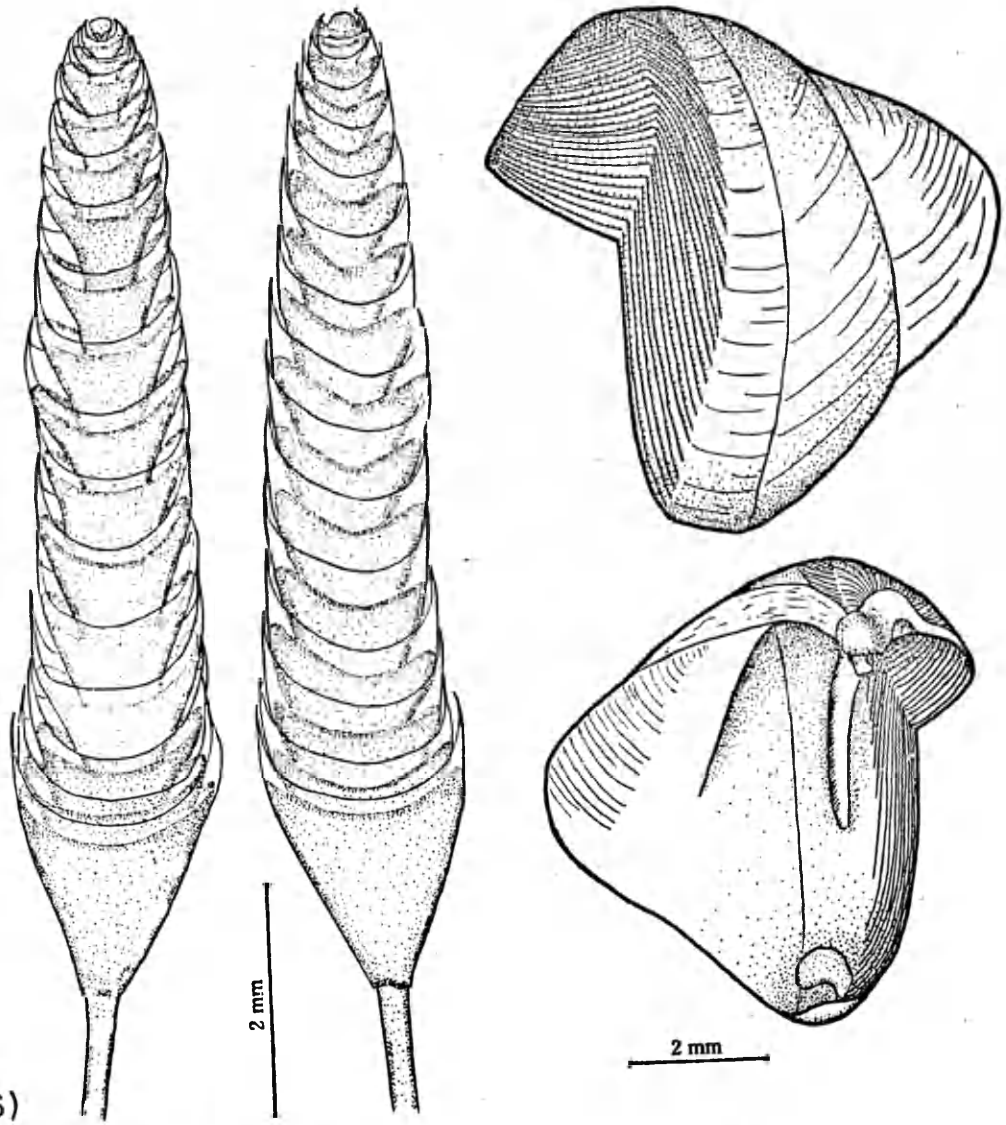
Fig. 44. Diplothyra smithii (from Turner, 1955)
a. Boring in oyster shell
b. Internal view of shell
c. Ventral view of apophysis and pedal gape
d. External view of shell


a
b
c
d



pallets

FIG. 45 *Teredo navalis* (from Turner, 1966)



pallets

FIG. 46 *Bankia gouldi* (from Clench, 1946)

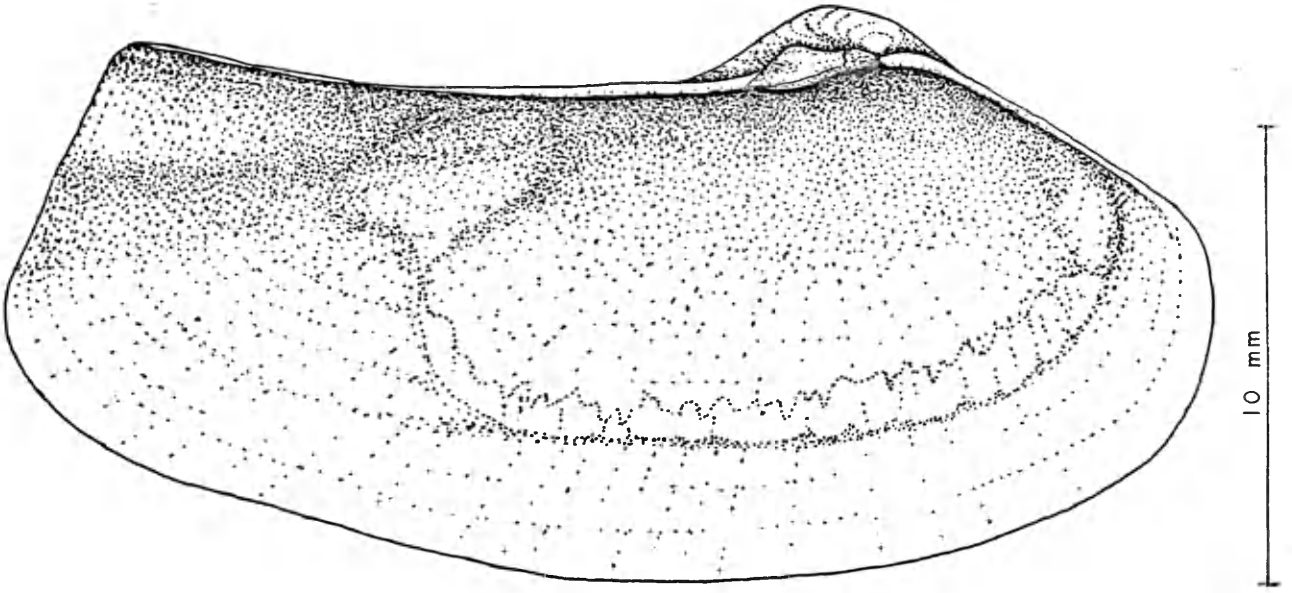


FIG. 47 *Lyonsia hyalina*

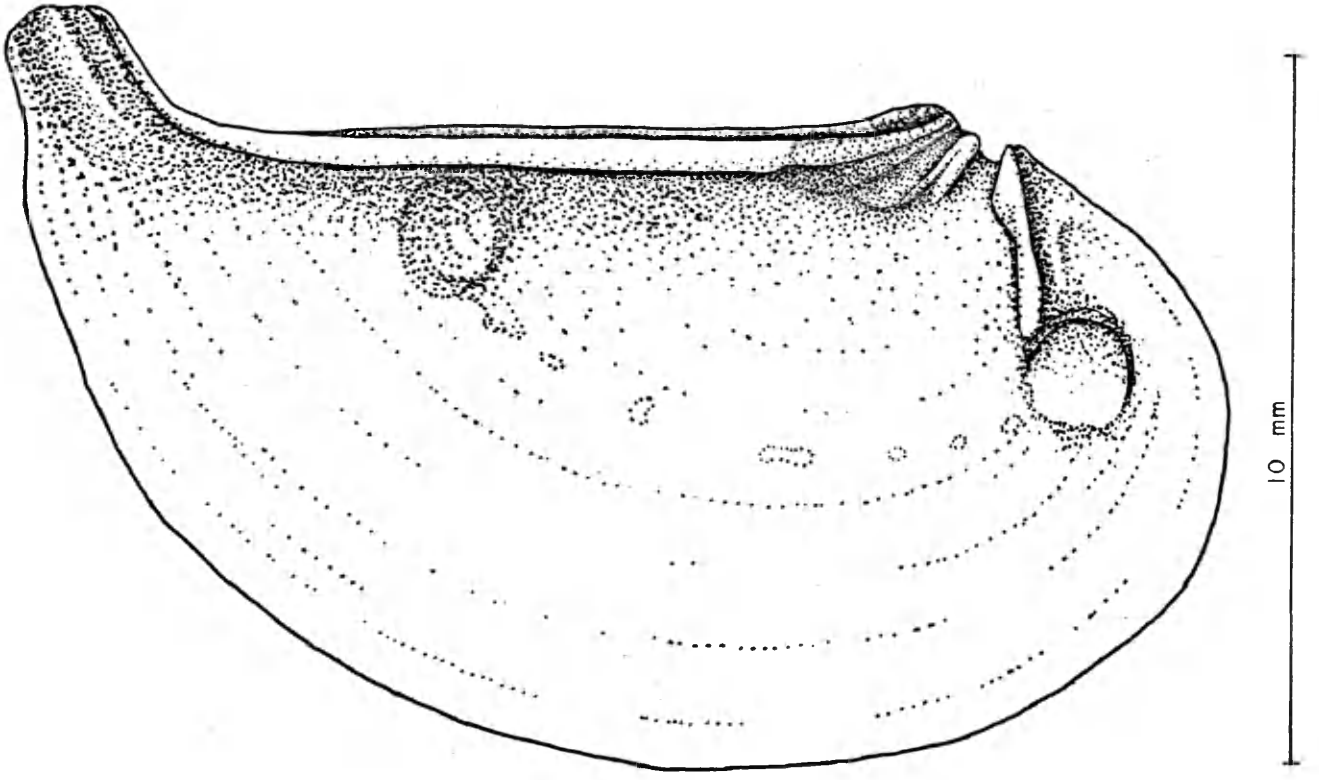


FIG. 48 *Pandora trilineata*

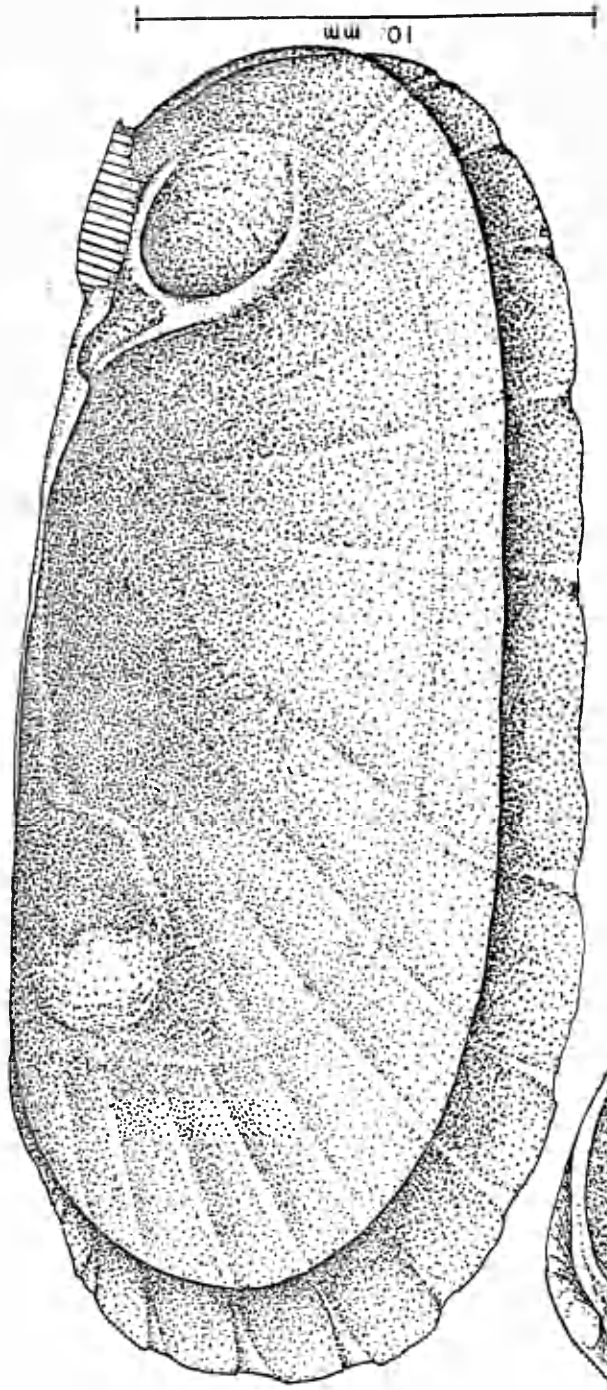


FIG. 50 *Solemya velum*

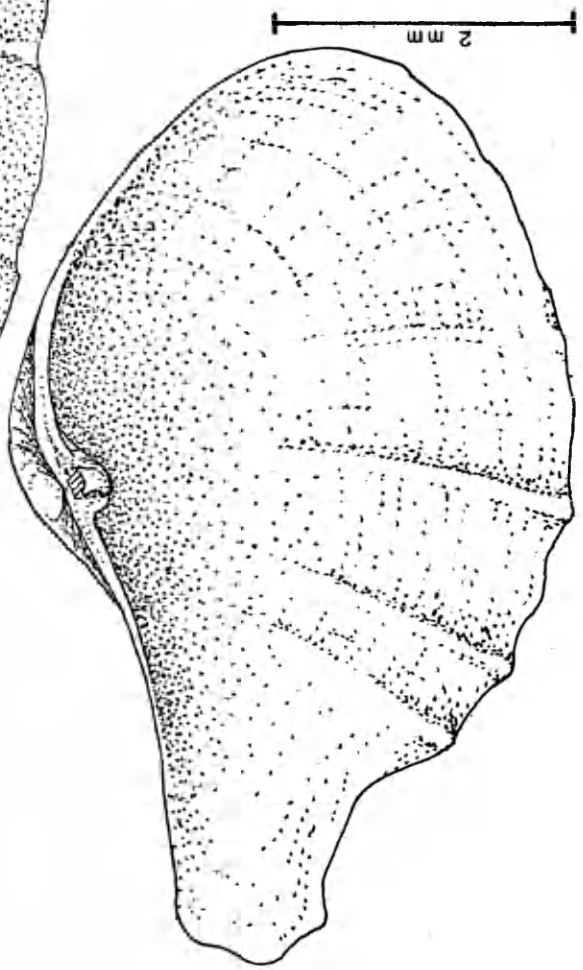


FIG. 49 *Cardiomya gemma*

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Entered the School of Marine Science of The College of William and Mary in Virginia, September 1965 with a graduate assistantship in the Malacology Department. Taught biology and earth science, Gloucester High School, Gloucester County, Virginia, September 1967 - January 1968. Received a second graduate assistantship in the Environmental Physiology Department, January 1968.